Pacific Fisheries Resource Conservation Council

Pacific Salmon Resources in Central and North Coast British Columbia

Prepared by
Dr. Brian Riddell
February 2004

Pacific Salmon Resources in Central and North Coast British Columbia
Brian Riddell

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For further information about this document and about the Pacific Fisheries Resource Conservation Council (PFRCC), contact:
Pacific Fisheries Resource Conservation Council
800 Burrard Street, Suite 590
Vancouver, BC, Canada V6Z 2G7
Telephone 604 775 5621
Fax 604 775 5622
www.fish.bc.ca
info@fish.bc.ca

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Pacific Fisheries Resource Conservation Council
Conseil pour la conservation des ressources halieutiques du pacifique

February 2004

The Hon. Geoff Regan
Minister of Fisheries & Oceans
Government of Canada
Ottawa

The Hon. John van Dongen
Minister of Agriculture, Food & Fisheries
Government of British Columbia
Victoria

Dear Ministers:

The status and prospects of salmon stocks and habitat in the northern and central coastal regions has been an on-going concern of British Columbians, especially in light of changes in monitoring and management of Pacific salmon.

Attached to this letter is the background paper entitled *Pacific Salmon Resources in Central and North Coast British Columbia.* It was authored by Dr. Brian Riddell to inform our Council and the public about current circumstances and trends.

Dr. Riddell's background paper chronicles the serious problems of inadequate information about the salmon stocks in the region, and it helps to inform the current discussion about how wild salmon stocks can be effectively managed in the absence of adequate records, sufficient data or valid scientific evidence in many cases. He makes a compelling case for increasing the level of federal government resources assigned to assessing the wild salmon stocks in order to ensure adequate and timely conservation.

The Council is reviewing this background paper for the purpose of issuing an advisory to both levels of government. We believe that the findings contained in this background paper are especially valuable and relevant to future government decisions on salmon assessment.

John A. Fraser
Chairman

590 - 800 Burrard Street
Vancouver, British Columbia
Canada V6Z 2G7

Tel/Tél: (604) 775-5621
Fax/Téléc: (604) 775-5622
E-mail: info@fish.bc.ca
Web Site/Site Web: www.fish.bc.ca

590 - 800 rue Burrard
Vancouver, Colombie-Britannique
Canada V6Z 2G7

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EXECUTIVE SUMMARY

This is the second in a series of three reports by the Pacific Fisheries Resource Conservation Council (PFRCC) describing the Pacific salmon resource in British Columbia (BC) and Yukon, its current state, and the ability to assess and understand this important resource. It deals with the wild salmon in central BC (DFO statistical areas 7 to 11) and northern BC (DFO statistical areas 1 to 6)[1]. In geographic terms this is the area from southern Queen Charlotte Sound northwards to Portland Canal, including the Queen Charlotte Islands.

The information in this report is derived from Fisheries and Oceans Canada salmon spawning records, reports reviewed and accepted by the Pacific Scientific Advice Review Committee (website: www-sci.pac.dfo-mpo.gc.ca/sci/psarc), and published technical references. Most of the data are reported numbers of salmon spawning in specific streams and based on visual surveys. While there is a long record of these observations, the accuracy of the estimates is usually unknown. Efforts are made to make the annual surveys comparable, but differences in the numbers of spawning salmon from year to year may reflect several sources of change; including actual production of progeny per spawner, fishing pressures, local effects of freshwater habitats, as well as revised procedures in annual spawning surveys. The interpretation of these data is typically limited to trends over time in specific streams or local areas. These data usually provide the only means to monitor continuance and abundance trends in these spawning populations, but they may not be representative of changes in production status since the catch for each stream is very seldom known. The data are frequently of limited value in explaining trends since there could be several possible causes of reductions in the number of spawners. There are, unfortunately, very few salmon populations in central and northern BC with the data necessary for such explanations.

Public attention is frequently focused on crisis and conflict over salmon issues and generally on the negative circumstances associated with salmon. **Salmon are indeed threatened by continued economic development, climate change, and human population growth. They also remain a diverse, highly dynamic, and resilient group of species.** This report attempts to document the breadth of this important resource in central and northern British Columbia and presents a long-term perspective on their stock status. Where possible, we comment on current challenges and monitoring programs.

Overview of Council Advice

The PFRCC provides comments at the end of each section of the report concerning each species. There is a strong common thread of problems and opportunities across the species and geographic area. It is a credit to past staff in Fisheries and Oceans Canada that such broad and informative sets of historical data exist for assessments and decision-making. However, this wealth of information is now not being sufficiently replenished and annual surveys of spawning escapements are being reduced for each species.

As noted in our report, in many cases the numbers of streams surveyed may still provide an adequate sample. This adequacy though depends upon their geographic distribution and the comparability of the information from current methods with historical ones.

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[1] Statistical areas are management zones used by federal department Fisheries and Oceans Canada, and are described in detailed maps at: www.pac.dfo-po.gc.ca/ops/fm/Areas/areamap_e.htm

Furthermore, the quality of data needed for an assessment is related to the intensity of fisheries, or other impacts, that are expected to affect the salmon populations. If harvest rates are expected to be high, then more quantitative data should be collected, and vise versa. Our major concern, though, is about how federal government budget reductions may undermine salmon stock assessments. At the same time, it is troubling to observe that too often decisions are made in response to budget restriction on an ad hoc basis, and not part of a planned response that matches information requirements to anticipated needs or long-term information values.

The PFRCC must stress an important point concerning the collected data and information. Given the limited quantitative information available for most species and areas in the central and northern regions, the historical escapements surveys and data are the core base for any future assessments. Even with the concerns for how repeatable survey methods have been over time or between streams, and the unknown accuracy of these surveys, they are the legacy of data that people must work with. There is potential to improve these surveys, but care must be taken in selecting which surveys are maintained and evaluating the comparability of future data with past information.

Given the obvious need to control budgets while providing information for resource assessment and fishery management decisions, the Council's strongest advice is to develop a core stock assessment framework for each species and area. The information needs will vary by species and location, but a commitment is needed to maintain a core annual program of essential information. This would provide stability to the information that will be available for future use and reduce risks of ad hoc decisions that could have detrimental impacts. The PFRCC is aware that Science Branch of Fisheries and Oceans Canada has discussed developing such plans and that the North Coast Stock Assessment program has been examining alternative assessment procedures for sockeye salmon. However, with the extent of reductions in stream surveys and the continuing concerns for budget reductions, there is an increasing urgency for the completion of these frameworks.

This report also identifies several specific issues for the consideration of Fisheries and Oceans Canada.

1. Fisheries and Oceans Canada should conduct a concerted assessment of the smaller sockeye lake populations during the next few years and study the genetic structure of these stocks in order to properly define the conservation units for sockeye.

2. Each chum population in the regions should be designated by run-timing and genetic variation between summer and fall chums should be assessed. Fisheries and Oceans Canada should establish some quantitative capacity to assess summer chum salmon, including the estimation of marine survival, fishery harvest impacts, and variability in productivity of these populations.

3. The indicator stock programs for coho and chinook salmon are essential to evaluate changes in marine survival rates and fishery impacts over time. Indicator stocks provide the only means that the Council is aware of to assess the causes of changes in coho and chinook production and to provide verification for the visual escapement surveys. We note that presently there are no indicator stocks for coho and chinook salmon in some areas of central and northern BC.

4. Fisheries and Oceans Canada should establish an assessment framework for each salmon species, and consider how the salmon "stocks" may be accounted for under the Canadian Species at Risk Act.

5. There should be a thorough review of the need and/or value of the major hatchery programs, addressing the questions of whether or not they are providing the expected or desired benefits, and how they could be modified to aid other populations, assessment programs, or uses. These evaluations should involve local communities in consultations.

Recent reductions in fishing pressures and improvements in marine survival of salmon provide positive indicators of better spawning, but we also know that these conditions will change over time. The outstanding question from our perspective is whether Fisheries and Oceans Canada and other resource users will be prepared to invest sufficiently in fisheries management and monitoring of Pacific salmon stocks to maintain the legacy of valuable data and information for future uses.

Summaries by Species

Sockeye salmon (*Oncorhynchus nerka*)

People commonly associate sockeye salmon in north and central BC with four major lake systems that have been important economic resources for many years. Many smaller sockeye lakes are, however, also important components of the biological diversity of this species. For example, Babine Lake in the upper Skeena River is the largest sockeye producing system in northern BC, and includes three large artificial spawning channels built during the 1960s. Babine Lake sockeye are the most accurately enumerated salmon in the region; the adults entering it have been counted past a fence since 1946 and juvenile production emigrating from the lake has been estimated each year since 1961. At the same time, there are 27 non-Babine sockeye lakes within the Skeena watershed but the ability to assess sockeye populations in these lakes is much more limited than for Babine Lake and their status much more uncertain.

While sockeye production from the Babine Lake system has definitely increased, there have been concerns for indirect effects on the smaller non-Babine sockeye systems. Most of the non-Babine systems showed a decline in spawning escapements resulting from fishing impacts, and then a subsequent recovery in escapements as fisheries were modified to reduce their bi-catch. However, the declines in non-Babine sockeye were not synchronous between systems or equal in their degree of decline.

Similarly, variable status was determined in sockeye systems outside of the Skeena River. Sockeye escapement to Meziadin Lake (Nass River) is increasing but returns to Owikeno and Long lakes (Rivers and Smith Inlets) are currently depressed. These latter two lakes include multiple spawning populations and are recovering from very poor marine survival during the mid-1990s. The status of another 116 sockeye lakes in central and northern BC is much more difficult to summarize.

Given the possibility that the numerous smaller sockeye populations could become management concerns the Council provided extensive tables and graphs in this report to qualify and compare conditions of the various spawning streams. The number of true sockeye populations is difficult to define when so many of the lake systems have multiple spawning streams and separate spawning escapement records. In central and northern BC, the spawning records report 236 sockeye streams and about half of these streams are surveyed on a regular basis. Between 1950 and 1990, between 110 and 118 streams were surveyed in six or mores years each decade. During the 1990s, funding limitations substantially reduced survey coverage in the coastal lakes and non-Babine systems in the Skeena River. Since the mid-1990s, fewer than 100 streams have been monitored annually and one-third of those are tributary to Babine, Owikeno, and Long lakes.

The Council notes that data are inadequate to assess the status of: most of the non-Babine sockeye lakes in the Skeena River; any of the 52 lakes listed as Unknown in our assessment of lakes outside of the Skeena; and, in the vast majority of the 22 lake systems listed as Depressed. Overall, these data shortcomings could involve approximately half of all the sockeye rearing lakes in central and northern British Columbia.

Pink Salmon (*Oncorhynchus gorbuscha*)

Pink salmon have a fixed two-year life cycle (i.e., no over-lap between years) producing separate even and odd-year lines of pink salmon production. Overall in central and northern BC, spawning has been recorded in about 520 different streams in the Odd-year line and over 600 streams in the Even-year line. Pink salmon production in the central region is dominated by the Atnarko/Bella Coola River system, but others have increased in significance during recent years (particularly the Kimsquit, Chuckwalla and Kilbella rivers). In the north, there are relatively few very large pink salmon populations (most notably the Lakelse River in the Skeena and the Yakoun during Even-years on Queen Charlotte Islands), but several moderate-sized rivers have substantial production. There are also areas where pink salmon have been much less abundant, including Smith and Seymour Inlets, the Nass River up-stream of the lower river, and Queen Charlotte Islands during odd-years.

The return of pink salmon to the Bella Coola (Area 8) region has dominated pink production in central and northern BC. Returns in the Even-year line have averaged 4 million since 1954 and have been three times more abundant than the Odd-year line. Recent annual production has become more stable between years and harvest rates (proportion of the production taken as catch) have been reduced to 20%-30%, on average.

In recent years there has been an increase in spawning escapements recorded in most of the pink salmon streams that were surveyed. These results are, however, confounded with a significant reduction in the number of streams surveyed (particularly during 2001 and 2002) and less frequent surveys between years, particularly during the 1990s. These reductions are in contrast with substantial effort invested by Fisheries staff to maintain surveys during the 1950 to 1990 period. Since there are very limited quantitative data on pink salmon in these regions, the historical spawning escapement surveys are the core of assessment information. Changes in the relative size of spawning populations between streams, and within a stream but between years, are the best available indicators of trends in pink salmon status. The recent reductions in escapement monitoring are of particular concern in the Skeena River where pink production can be substantial in both year lines.

Chum Salmon (*Oncorhynchus keta*)

Chum salmon have been reported in 140 different streams in central BC and 470 different streams in the north since 1950. The estimated average escapements in the central region have consistently been about 500,000 since the 1950s. The distribution of spawning population sizes includes a few large populations and a much wider variety of moderate to small populations. Very few streams are reported to have, on average, more than 10,000 chum spawners. In northern BC, the total estimate of chum spawning escapements has declined from as high as one million to possibly half of that number, but any analysis of the changes in total escapement must account for the variable number of streams surveyed over time. As in the central area, very few of the northern chum streams are reported, on average, to have more than 10,000 chum spawners per year.

In both regions, the distribution of spawning population sizes between streams has changed substantially over time. Of the streams surveyed, those associated with major hatcheries have increased in numbers of spawners, but most medium-sized and smaller populations are now smaller than in past years. This is most pronounced in the north, but is also true for smaller populations in central BC.

Given the remoteness of some rivers and the local climate, the consistency of the spawning escapement monitoring for central BC chum salmon is exceptional. During the 53 years of recorded escapements, over half of these streams were enumerated 40 or more years. Coverage of escapement surveys between streams in north has not been as consistent, but there were still 33% of the 470 different streams enumerated in 40 or more years. This number of streams (155 different ones) with high frequency of surveys could provide an adequate sampling basis for monitoring of northern chum, depending on the distribution of the streams and the consistency of the survey methods. However, the number of streams surveyed for chum escapements in the regions declined during the 1990s, and much more during 2001 and 2002. While the estimates of chum spawning escapements have been increasing in recent years, this reduction in survey coverage could compromise a long history of detailed information.

The frequency of escapement surveys does not address concerns about the accuracy of these data, but the consistent effort over time and large set of streams monitored provides a large dataset for assessing chum salmon. As with pink salmon, this depth of historical information, based on the visual escapement surveys, is the core of the Department's assessment capacity for chum salmon. Unfortunately, the trend is to reduced survey coverage which could substantially weaken our capability to assess chum salmon. Careful attention should be given to which streams will continue to be monitored.

Chum enhancement activities in these regions are quite diversified, involving unmanned spawning channels, numerous small-scale programs managed by local groups, and major hatchery programs. The vast majority of the releases, though, are associated with the major hatcheries: Snootli Hatchery (Bella Coola River), Kitimat Hatchery (Kitimat), and the Pallant Creek Hatchery (Cumshewa Inlet, Area 2E).

Coho Salmon (*Oncorhynchus kisutch*)

Coho salmon are the most widely distributed of the wild salmon in central and northern BC. The escapement records since 1950 list 745 streams with coho spawning. These numbers are likely conservative as the late spawning season for coho makes their visual enumeration difficult. Estimates of coho spawning numbers and their distribution are almost certainly under estimated. For the same reasons, our ability to assess coho salmon in the vast majority of streams is very limited, and more so in remote watersheds.

In central BC, coho salmon have been reported in essentially the same number of streams as the chum salmon (137 steams plus 2 spawning channels). Coho returns to the Bella Coola River system account for the majority of the central region coho escapement. Essentially all these coho escapement data are based on visual surveys and are acknowledged to be of limited value for assessment (counts to the Bella Coola system are the most complete). Based on the escapement data only, central BC coho spawning escapements had been declining through to the late 1990s, but have increased very recently. It is notable that there are no quantitative indicator sites for coho salmon in central BC, but Fisheries and Oceans Canada is attempting to establish one in the Martin River, near Ocean Falls.

Unlike central BC surveys for pink and chum salmon, the vast majority of coho streams have recorded escapements in less than half of the years, and the consistency of inspections by streams has not been as well maintained. The reduction in surveys has continued during 2001 and 2002.

Coho salmon in the north are widely distributed and reported in over 600 streams. Trends in their spawning escapements have been similar to the pattern in the central region. The poorest recorded return of coho salmon occurred in the Skeena River in 1997, leading to a controversial fishing closure. Coho returns have apparently improved in recent years based on: increases in the reported escapements based on the visual surveys; improved annual indices in the Skeena test fishery; and increased marine survival estimated in four indicator stocks. Quantitative programs for spawning escapements and tag recovery are maintained in four northern indicator stock programs, but there is no equivalent program in the Queen Charlotte Islands (or in central BC).

Monitoring of spawning escapements to other northern coho streams is problematic. Only 14% of these streams have annual records for 40 or more years, and the distribution of spawning population sizes suggests a significant reduction in the number of spawners in many of the streams. This latter trend is of particular concern since the reduced escapements have been occurring in spite of numerous enhancement programs. This limited ability to enumerate spawners and the limited number of streams with an adequate number of years of data indicates why the four indicator stocks are essential for assessment of coho salmon. Information from the indicator stocks allows estimates of fishing impacts and distribution of the stocks, variation in marine survival rates between years, and estimation of productivity in the freshwater habitats.

Coho enhancement in the regions involves three major hatcheries and many enhancement strategies using smaller scale programs. Coded-wire tagging of coho released from enhancement facilities has provided good information on the distribution of these coho populations in Alaskan and Canadian fisheries. However, in many cases, the total spawning return has not been quantitatively estimated or sampled for tag returns. Given the major changes in fishing impacts over time and the variability evident in marine survival, quantitative escapement data are essential for full utilization of this tagging data and for assessment of trends through time.

Chinook salmon (*Oncorhynchus tshawytscha*)

Chinook salmon in central and northern BC are the most diverse of the species in terms of life history variations, but are the least abundant and utilize the fewest streams. Life history variation in chinook includes differences in length of freshwater rearing in juveniles, seasonality of adult return migrations, and size or age-at-maturity of adults.

In central BC, chinook salmon have been reported in 30 different streams, but only nine of these have escapement records that average greater than 100 spawners. Numerically, chinook in the region are dominated by returns to the Bella Coola River system including the Atnarko River and the Snootli Creek Hatchery, frequently five to tens times more than the next largest chinook system. In the north, chinook salmon utilize substantially more streams (105 different streams) and have been consistently reported in about 83 streams. By northern sub-areas, the Queen Charlotte Islands have only one chinook population (Yakoun River), and the Skeena River has about 40 chinook systems, but the interior Nass River, north coastal areas, and Kitimat Arm each have about 14 streams which consistently reported chinook. Most of these populations declined in escapements through the 1970s, but trends for more recent years vary depending on: return timing of the adults (earlier returning chinooks have had greater reductions in fishing impacts); the extent of enhancement in the system; and changes in marine survival rates. Spawning escapements have been increasing in many central and northern BC populations, but areas of concern remain that required more detailed investigations.

Enumeration efforts for chinook spawning escapements are highly variable between areas. In the central region, only nine chinook systems have been surveyed in over half of the years since 1950 and the methods used in some areas and years were poorly documented. The most thorough escapement assessments are in the Bella Coola/Atnarko system and the Dean River. In the north, the vast majority of the escapement surveys are based on visual methods and the frequency of surveys has been better than in the central region. Efforts have also been made to provide more quantitative estimates, such as the Nisga'a Tribal Council program estimating the return of chinook salmon to the upper Nass River using a mark-recapture program. In the Skeena River, chinook salmon are counted as they pass the Babine River fence and, since 1984, the Kitsumkalum summer chinook has been the only northern indicator stock. Data from the Kitsumkalum indicator stock has been particularly useful in identifying changes in fishing pressures from changes in marine survival. Unfortunately, and as with coho salmon, the absence of a tagged indicator stock for central BC chinook severely limits any assessment of fishing impacts and changes in survivals for that region. Continued reductions in DFO funding are reducing the numbers of streams surveyed each year, and some have resulted in a significant loss of information in recent years.

Enhancement of chinook salmon in the regions involves the two major hatcheries (Snootli Creek and Kitimat) and several smaller community programs. Enhancement strategies and releases of chinook are explained in detail in this report. In many of the river systems though, an assessment or accounting of hatchery returns cannot be presented because of the lack of information about escapement to the spawning grounds.

RÉSUMÉ

Saumon du Pacifique : État de la ressource sur les côtes centrale et nord de la Colombie-Britannique

Le présent document est le second d'une série de trois rapports publiés par le Conseil pour la conservation des ressources halieutiques du Pacifique (CCRHP). Ces rapports visent à décrire la ressource en Colombie-Britannique et au Yukon, son état actuel et notre capacité à évaluer et à comprendre cette importante ressource. Le présent rapport traite des saumons sauvages qui fréquentent le Centre (secteurs statistiques 7 à 11 de MPO) et le Nord (secteurs statistiques 1 à 6 de MPO)[2] de la Colombie-Britannique. En termes géographiques, il s'agit de la région qui s'étend du sud de la baie de la Reine-Charlotte au canal Portland Canal, au nord, et qui comprend les îles de la Reine-Charlotte.

Les informations contenues dans ce rapport proviennent des données recueillies par Pêches et Océans Canada sur le frai des saumons, des rapports examinés et approuvés par le Conseil pour la conservation des ressources halieutiques du Pacifique (site Web : www-sci.pac.dfo-mpo.gc.ca/sci/psarc) et de plusieurs articles techniques. La plupart des données concernent l'effectif estimé visuellement des géniteurs dans les différents cours d'eau. Ce type d'estimations existe depuis longtemps mais on ignore généralement la précision des chiffres obtenus. Même si l'on s'efforce d'effectuer les relevés annuels de la même manière d'une année à l'autre, les variations annuelles d'effectif enregistrées peuvent en fait refléter divers facteurs, notamment la natalité effective par géniteur, la pression halieutique, l'évolution des habitats dulcicoles et l'introduction éventuelle de nouvelles procédures lors de la mise en œuvre des relevés annuels des géniteurs. Seules des tendances générales concernant des cours d'eau spécifiques ou des secteurs particuliers peuvent en général être extraites de ces données qui restent cependant les seules informations disponibles pour surveiller les populations de saumons. Ces données peuvent ne pas refléter fidèlement les fluctuations de production puisqu'on ne connait que très rarement le nombre de prises effectuées par les pêcheurs sur chaque cours d'eau. Ces données n'ont donc le plus souvent qu'une utilité limitée pour expliquer les tendances observées puisque toute réduction d'effectif chez les géniteurs peut provenir de causes diverses. Malheureusement, seules un très petit nombre de populations de saumons dans le Centre et le Nord de la Colombie-Britannique sont étudiées de suffisamment près pour que l'on puisse expliquer en détail les fluctuations observées.

L'attention du public se porte souvent sur les crises et les conflits liés au saumon et généralement sur les évolutions négatives notées dans ce domaine. **S'il est vrai que les saumons sont menacés par le constant développement économique, les changements climatiques et l'accroissement de la population humaine, il n'en reste pas moins qu'ils constituent des groupes d'espèces très dynamiques et très résilients.** Le présent rapport a pour objet de décrire l'importance de cette ressource dans le Centre et le Nord de la Colombie-Britannique et d'évaluer son avenir à long terme. On y commente également les enjeux et les programmes de surveillance actuels.

Survol des recommandations formulées par le Conseil

Le CCRHP offre ses commentaires à la fin de chaque chapitre du rapport consacré à une espèce particulière. Les problèmes et les possibilités sont très similaires d'une espèce à l'autre et d'un secteur à l'autre. C'est grâce aux efforts des anciens employés de Pêches et Océans Canada qu'un tel vaste ensemble de données détaillées est aujourd'hui disponible pour l'évaluation et la prise éclairée des décisions. Aujourd'hui, cette banque de données n'est cependant pas suffisamment alimentée et les relevés annuels des échappées ont été réduits pour chacune des espèces.

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[2] Les secteurs statistiques sont des zones de gestion utilisées par le ministère fédéral des Pêches et des Océans. Ils sont décrits en détails à : *www.pac.dfo-po.gc.ca/ops/fm/Areas/areamap_f.htm*

Comme on le mentionne le présent rapport, dans de nombreux cas, le nombre de cours d'eau étudiés permet encore probablement d'obtenir un échantillonnage adéquat. L'utilité des données recueillies dépend néanmoins de la distribution géographique des relevés et du degré de comparabilité entre les données modernes et les données historiques.

La qualité des données nécessaires pour une évaluation est de plus liée à l'intensité de l'effort halieutique et aux autres activités susceptibles d'affecter les populations de saumons. Si l'on prévoit que les taux de récolte seront élevés, il faut essayer de recueillir plus de données et vise versa. Notre préoccupation principale porte cependant sur la façon dont les réductions des budgets fédéraux vont affecter les évaluations des stocks de saumons. Il est troublant de constater que les décisions sont trop souvent prises en réaction à des coupures budgétaires, au cas par cas, plutôt qu'en harmonie avec un processus de planification qui adapterait les efforts de collectes de données aux besoins anticipés et à la valeur à long terme de ces collectes.

Le CCRHP doit souligner un point important concernant les données et les informations recueillies. Compte tenu de la quantité limitée d'informations quantitatives disponibles pour la plupart des espèces et des secteurs dans les régions du Centre et du Nord, les relevés historiques des échappées constituent le noyau de base des informations sur lesquelles seront basées les évaluations à venir. Même si l'on peut se demander si les relevés ont été conduits de façon suffisamment semblable d'une année à l'autre ou d'un cours d'eau à l'autre et même si l'on ignore la précision réelle de ces relevés, ces derniers n'en constituent pas moins la quasi totalité des données que doivent aujourd'hui analyser les spécialistes. Ces relevés peuvent certainement être améliorés mais il faut faire preuve de beaucoup de prudence lorsque l'on sélectionne les relevés qui seront maintenus et que l'on évalue la comparabilité entre les données futures et celles du passé.

Compte tenu du besoin évident de contrôler les budgets tout en produisant les données nécessaires à l'évaluation de la ressource et aux prises de décisions concernant la gestion des pêches, le Conseil recommande fortement de mettre sur pied un cadre d'évaluation de base pour chaque espèce et pour chaque secteur. Les besoins en données varient suivant les espèces et les secteurs mais un engagement du gouvernement à ce niveau est nécessaire si l'on veut maintenir un programme de base de collecte d'informations essentielles. Un tel effort assurerait la stabilité de la base de données qui serait ainsi disponible dans l'avenir et permettrait d'éviter les décisions opportunistes qui avoir des impacts négatifs. Le CCRHP sait que la Direction scientifique de Pêches et Océans Canada a envisagé l'élaboration de tels plans et que le programme d'évaluation des stocks de la côte nord a permis d'examiner de nouvelles procédures d'évaluation pour le Saumon rouge. L'étendue des réductions des relevés dans les cours d'eau et les coupures budgétaires rendent cependant urgente la mise sur pied de ces cadres d'évaluations de base.

Le présent rapport vise également à identifier plusieurs enjeux spécifiques et à les soumettre à l'attention de Pêches et Océans Canada.

1. Pêches et Océans Canada devrait effectuer, au cours des prochaines années, une évaluation concertée des petites populations de saumons rouges qui vivent dans les lacs et étudier la structure génétiques de ces stocks de façon à définir correctement les unités de conservation destinées aux saumons rouges.

2. Chaque population de saumons Kéta dans les différentes régions devrait être identifiée en fonction de la date de remonte des saumons et il serait bon d'évaluer les variations génétiques entre les saumons Kéta de printemps et ceux d'automne. Pêches et Océans Canada devrait développer la capacité d'évaluer les populations de saumons Kéta d'été, notamment leur taux de survie en mer, l'impact des pêches et la variabilité de leur productivité.

3. Les programmes de stocks indicateurs pour les saumons coho et les saumons Quinnat sont essentiels pour la surveillance de l'évolution des taux de survie en mer et de l'impact des pêches. Autant que le Conseil sache, les stocks indicateurs constituent le seul moyen disponible permettant de surveiller l'évolution de la production des saumons Coho et des saumons Quinnat et de vérifier les données recueillies lors des relevés visuels des échappées. Nous notons que dans quelques secteurs du Centre et du Nord de la Colombie-Britannique, il n'existe à l'heure actuelle aucun stock indicateur, ni pour les saumons Coho ni pour les saumons Quinnat.

4. Pêches et Océans Canada devrait mettre sur pied un cadre d'évaluation pour chaque espèce de saumons et étudier la manière dont la *Loi sur les espèces en péril* du Canada pourrait s'appliquer aux « stocks » de saumons.

5. Il faudrait effectuer un examen détaillé du besoin et de l'utilité des principaux programmes d'écloserie, en déterminant si ces programmes apportent les bénéfices escomptés, comment ils pourraient être éventuellement modifiés pour aider d'autres populations de saumons ou contribuer à d'autres programmes d'évaluation ou à d'autres utilisations. Ces évaluations devraient faire participer les communautés locales lors de séances de consultation.

La réduction récente de la pression halieutique et l'amélioration du taux de survie en mer des saumons ont contribué à une amélioration de la production, mais il est clair que ces conditions vont évoluer. La question qui reste en suspend, à notre avis, est de savoir si Pêches et Océans Canada et les autres utilisateurs de la ressource seront prêts à investir suffisamment dans la gestion des pêches et la surveillance des stocks de saumons du Pacifique pour que soit entretenue et mise à jour la base de données et d'informations pour les utilisations futures.

Résumé par espèces

Saumon rouge (*Oncorhynchus nerka*)

Le public associe communément les saumons rouges du Centre et du Nord de la Colombie-Britannique avec quatre systèmes lacustres qui sont restés d'importantes ressources économiques pendant de nombreuses années. Un grand nombre de lacs plus petits abritent néanmoins également du Saumon rouge et sont des composantes importantes de la diversité biologique de cette espèce. Le lac Babine, par exemple, dans le cours supérieur de la Skeena, est le plus grand système producteur de saumons rouges du Nord de la Colombie-Britannique. On y trouve trois frayères artificielles construites durant les années 1960. La population des saumons rouges du lac Babine est la population de saumons la mieux recensée de la région; les adultes qui pénètrent dans le lac étant comptés au niveau d'une porte depuis 1946 et le nombre de jeunes qui en sortent faisant l'objet d'une estimation annuelle depuis 1961. Il existe également 27 lacs indépendants du lac Babine qui abritent des saumons rouges dans le bassin hydrographique de la Skeena mais notre capacité d'évaluer ces populations est bien plus limitée et leur statut est très incertain.

Bien que la production des saumons rouges du système du lac Babine ait sans conteste augmenté, on s'inquiète de certains impacts sur les autres systèmes plus petits qui abritent eux aussi des saumons rouges. Les échappées pour la plupart des systèmes autres que celui du lac Babine ont décliné à cause de la pression halieutique puis se sont rétablies à la suite de l'adaptation des pêches visant à réduire les prises accessoires. Les déclins observés dans ces systèmes secondaires n'ont été ni synchrones ni de même amplitude.

De même, le statut des populations de saumons rouges à l'extérieur du bassin de la Skeena est variable. L'échappée de saumons rouges vers le lac Meziadin (bassin de la Nass) est en augmentation mais les remontes vers les lacs Owikeno et Long (inlets Rivers et Smith) sont présentement faibles. Ces deux lacs abritent de nombreuses populations de géniteurs qui se reconstituent lentement à la suite des répercussions qu'avaient eu de très faibles taux de survie en mer survenus dans le milieu des années 1990. Le statut de 116 autres lacs qui abritent des saumons rouges dans le Centre et le Nord de la Colombie-Britannique est beaucoup plus difficile à résumer.

Compte tenu qu'il est possible que l'état de nombreuses petites populations de saumons rouges devienne préoccupant, le Conseil a décidé d'inclure dans ce rapport un grand nombre de tableaux et de graphiques permettant d'évaluer et de comparer les conditions des divers cours d'eau recelant des frayères. L'effectif exact des populations de saumons rouges est difficile à établir car un grand nombre de systèmes lacustres sont reliés à de multiples cours d'eau contenant des frayères et ont leurs propres donnés d'échappées. Dans le Centre et le Nord de la Colombie-Britannique, les données sur le frai des saumons rouges proviennent de 236 cours d'eau et près de la moitié d'entre eux sont régulièrement recensés. Entre 1950 et 1990, entre 110 et 118 cours d'eau ont fait l'objet de relevés annuels au moins six années pour chaque décennie. Pendant les années 1990, les restrictions budgétaires ont engendré une réduction significative de la couverture des relevés dans les lacs côtiers et les systèmes autres que celui du lac Babine dans le bassin de la Skeena. Depuis le milieu des années 1990, moins de 100 cours d'eau ont été surveillés une fois par an et un tiers de ceux-ci sont des affluents des lacs Babine, Owikeno et Long.

Le Conseil note que les données ne permettent pas d'évaluer le statut ni de la plupart des lacs à saumons rouges autre que le lac Babine dans le bassin de la Skeena, ni de l'ensemble des 52 lacs portant la mention « statut inconnu » dans notre évaluation des lacs situés à l'extérieur du bassin de la Skeena, ni de grande majorité des 22 systèmes lacustres portant la mention « appauvri ». Au total, ces lacunes dans les données pourraient concerner approximativement la moitié de tous les lacs à saumons rouges du Centre et du Nord de la Colombie-Britannique.

Saumon rose (*Oncorhynchus gorbuscha*)

Les saumons roses ont un cycle de vie fixe de deux ans qui explique l'existence de deux lignées distinctes, celle des années paires et celle des années impaires, qui ne se chevauchent jamais. Dans le Centre et le Nord de la Colombie-Britannique, l'effectif des géniteurs a été enregistré dans près de 520 cours d'eau pour la lignée des années impaires et dans plus de 600 cours d'eau pour la lignée des années paires. La production des saumons roses dans la région du centre est dominée par celle du système des rivières Atnarko et Bella Coola mais d'autres systèmes ont pris de l'importance au cours des dernières années (en particulier celui des rivières Kimsquit, Chuckwalla et Kilbella). Dans le Nord, les grandes populations de saumons roses sont relativement peu nombreuses (on peut mentionner celle de la rivière Lakelse, dans le bassin de la Skeena, et celle de la rivière Yakoun pour la lignée des années paires, sur les îles de la Reine-Charlotte), mais plusieurs rivières de taille modeste produisent néanmoins un nombre substantiel de saumons. Dans certains secteurs, le Saumon rose a été beaucoup moins abondant, notamment dans les inlets Smith et Seymour, dans la Nass en amont de son cours inférieur et dans les îles de la Reine-Charlotte durant les années impaires.

Le frai des saumons roses dans la région de Bella Coola (Secteur 8) domine la production de cette espèce dans le Centre et le Nord de la Colombie-Britannique. Les remontes des années paires chiffrent en moyenne 4 millions de poissons depuis 1954 et sont trois fois plus abondantes que celles des années impaires. Récemment, la production annuelle est devenue plus stable d'une année à l'autre et le taux de récolte (proportion de la production qui est capturée) a été réduit à entre 20 % et 30 % en moyenne.

Au cours des dernières années, on a observé une augmentation de l'effectif des échappées dans la plupart des cours d'eau à saumons roses surveillés. Ces résultats sont cependant remis en cause par une réduction significative du nombre de cours d'eau étudiés (en particulier en 2001 et en 2002) et des relevés moins fréquents entre les années, en particuliers durant les années 1990. Ces réductions sont apparues malgré les efforts importants mis en œuvre par le personnel des pêches pour poursuivre les relevés entre 1950 et 1990. Les données quantitatives concernant le Saumon rose étant très limitées dans ces régions, les données historiques issues des relevés d'échappée constituent la base de l'information pour les évaluations. L'évolution de la taille relative des populations de géniteurs d'un cours d'eau à l'autre et d'une année à l'autre pour le même cours d'eau est le meilleur des indicateurs pour ce qui est des tendances affectant le statut des saumons roses. La réduction récente de la surveillance des échappées dans la Skeena est préoccupante. La production des saumons roses peut y être substantielle pour les deux lignées (années paires et années impaires).

Saumon Kéta (*Oncorhynchus keta*)

Les saumons Kéta ont été observés dans 140 cours d'eau du Centre de la Colombie-Britannique et 470 cours d'eau du Nord de la province depuis 1950. L'effectif total des échappées dans la région du Centre se monte régulièrement à 500 000 spécimens en moyenne depuis les années 1950. Il existe quelques populations de grande taille et un nombre beaucoup plus important de populations de taille modérée à faible. Seuls un très petit nombre de cours d'eau abritent en moyenne plus de 10 000 saumons Kéta géniteurs. Dans le Nord de la Colombie-Britannique, l'effectif total estimé des échappée est tombé d'un million de poissons à cinq cent milles mais l'analyse de l'évolution de l'effectif total des échappées doit tenir compte du nombre variable de cours d'eau surveillés. Comme c'est le cas dans la région du Centre, un très petit nombre des cours d'eau à saumons Kéta semblent abriter en moyenne plus de 10 000 géniteurs par an.

Dans les deux régions, la distribution des populations de géniteurs entre les différents cours d'eau a évolué de manière substantielle avec le temps. Parmi les cours d'eau surveillés, ceux qui sont associés à une écloserie on vu leur effectif de géniteurs augmenter mais les populations de taille moyenne ou faible compte aujourd'hui moins de spécimens que par le passé. Ce phénomène est plus prononcé dans le Nord mais c'est également le cas pour les petites populations du Centre de la Colombie-Britannique.

Compte tenu de l'éloignement de certaines rivières et du climat local, il faut reconnaître que l'effort de surveillance des échappées des saumons Kéta géniteurs dans le Centre de la Colombie-Britannique est exceptionnel. Sur les 53 années de surveillance, plus de la moitié de ces cours d'eau ont fait l'objet d'au moins 40 recensements annuels. La couverture des relevés d'échappée dans le Nord n'a pas été aussi bonne mais 33 % des 470 cours d'eau y ont néanmoins fait l'objet d'au moins 40 recensements annuels. Ces cours d'eau recensés régulièrement (au nombre de 155) pourraient constituer une base d'échantillonnage pour la surveillance du Saumon Kéta dans le Nord si leur distribution est relativement homogène et que les méthodes de recensement utilisées restent suffisamment stables. Le nombre de cours d'eau où les échappées de saumons Kéta ont été dénombrées dans ces régions a diminué dans les années 1990 et encore plus entre 2001 et 2002. Bien que les effectifs estimés des échappées aient augmenté au cours des dernières années, la réduction de la surveillance compromet la viabilité à long terme de la base de données.

La fréquence des relevés d'échappées n'améliore en rien la précision des données recueillies mais la constance et la couverture de l'effort de surveillance permet d'accumuler suffisamment de données pour évaluer l'état des populations de saumons Kéta. Comme c'est le cas pour le Saumon rose, cette accumulation de données historiques provenant des relevés visuels constitue la base de la capacité d'évaluation du ministère pour ce qui est des saumons Kéta. Malheureusement, la couverture des relevés a tendance à être réduite, ce qui pourrait, à long terme, affaiblir sérieusement notre capacité d'évaluer l'état des populations des saumons Kéta. Il faut décider avec prudence quels cours d'eau continuera à faire l'objet de relevés.

Les activités de mise en valeur des saumons Kéta dans ces régions sont assez diverses, mettant notamment en jeu des frayères artificielles sans personnel d'entretien, un grand nombre de programmes à petite échelle gérés par des groupes locaux et d'importants programmes d'écloserie. La grande majorité des lâchers sont néanmoins effectués par les grandes écloseries : celle de la rivière Snootli Creek (bassin de la rivière Bella Coola), celle de la rivière Kitimat (Kitimat) et celle de la rivière Pallant Creek (inlet Cumshewa, secteur 2E).

Saumon coho (*Oncorhynchus kisutch*)

Les saumons Coho sont les plus répandus des saumons sauvages dans le Centre et le Nord de la Colombie-Britannique. Les données d'échappées enregistrées depuis 1950 font état de 745 cours d'eau abritant des frayères fréquentées par des saumons Coho. Le nombre réel est probablement plus élevé car le dénombrement de ces saumons qui fraient tard est difficile. Pour la même raison, le nombre et la distribution des géniteurs sont très probablement sous estimés et notre capacité d'évaluer les populations de saumons Coho dans la vaste majorité des cours d'eau est très limitée, en particulier dans les bassins hydrographiques éloignés.

Dans le Centre de la Colombie-Britannique, les saumons Coho ont été observés dans un nombre de cours d'eau sensiblement identique à celui des cours où le Saumon Kéta a été recensé (137 cours d'eau et 2 frayères artificielles). Les remontes de saumons Coho dans le système de la rivière Bella Coola donne lieu à la majorité des échappées de ce poisson dans la région du Centre. Presque toutes les données d'échappée du Saumon Coho sont basées sur des relevés visuels et sont réputées être d'une utilité limitée pour les évaluations (les dénombrements effectués sur le système de la rivière Bella Coola sont les plus complets). Si l'on en croit ces données d'échappée, les effectifs des échappées de saumons Coho géniteurs dans le Centre de la Colombie-Britannique ont diminué à la fin des années 1990 mais sont remontés très récemment. Fait remarquable, il n'existe aucun site indicateur quantitatif pour le Saumon Coho dans le Centre de la Colombie-Britannique. Pêches et Océans Canada essaie cependant d'en mettre un sur pied sur la rivière Martin, près d'Ocean Falls.

Contrairement aux relevés des saumons roses et des saumons Kéta dans le Centre de la Colombie-Britannique, les relevés des saumons Coho dans cette région ont été effectués moins d'une année sur deux et leur continuité sur les cours d'eau n'a pas été aussi bien maintenue. La fréquence des relevés a continué à diminuer entre 2001 et 2002.

Dans le Nord, les saumons Coho occupent une vaste aire de distribution puisqu'on les a observés dans plus de 600 cours d'eau. L'évolution des effectifs des échappées ressemble à celle observée dans la région du Centre. La remonte la plus déprimée a été observée sur la rivière Skeena en 1997, ce qui entraîna l'instauration d'une fermeture très controversée. Les remontes de saumons Coho se sont apparemment améliorées au cours des dernières années si l'on en croit l'augmentation des effectifs des échappées dénombrés lors des relevés visuels, l'amélioration des indicateurs annuels dans la pêche d'essai de la Skeena et l'augmentation estimée du taux de survie en mer pour quatre stocks indicateurs. Quatre programmes quantitatifs pour des stocks du

Nord visant à dénombrer visuellement les échappées et à procéder à des recensements à l'aide d'étiquettes sont maintenus mais il n'y a aucun programme équivalent dans les îles de la Reine-Charlotte (ou dans le Centre de la Colombie-Britannique).

La surveillance des échappées dans les autres cours d'eau à saumons Coho dans le Nord est problématique. Seulement 14 % de ces cours d'eau ont fait l'objet d'au moins 40 recensements annuels et la distribution de la taille des échappées suggère une réduction importante des effectifs des géniteurs dans un grand nombre des cours d'eau. Cette tendance est particulièrement préoccupante car elle s'est installée malgré la mise en œuvre de nombreux programmes de mise en valeur. Notre capacité limitée de dénombrer les géniteurs et le nombre restreint de cours d'eau ayant fait l'objet de suffisamment de relevés expliquent l'importance des quatre stocks indicateurs pour l'évaluation de l'état des populations de saumons Coho. Les informations provenant de ces stocks permettent d'estimer l'impact de la pêche et la distribution des stocks, l'évolution du taux de survie en mer d'une année à l'autre et la productivité en eau douce.

La mise en valeur du Saumon Coho dans les régions s'effectue dans trois grandes écloseries et par l'intermédiaire d'un grand nombre de stratégies mettant en œuvre des programmes à plus petite échelle. Le marquage des saumons cohos provenant des installations de mise en valeur a permis de recueillir des informations de bonne qualité sur la distribution de ces populations de saumons Coho dans les pêches de l'Alaska et de la Colombie-Britannique. Dans bien des cas, l'effectif total des remontes n'a cependant pas été estimé ou aucun relevé d'étiquettes n'a été fait sur le terrain. Compte tenu de l'évolution de la pression halieutique et de la variabilité observée du taux de survie en mer, il est cependant essentiel de recueillir des données quantitatives sur les échappées afin d'utiliser pleinement les données issues des programmes de marquage et de pouvoir évaluer les tendances démographiques actuelles.

Saumon Quinnat (*Oncorhynchus tshawytscha*)

Dans le Centre et le Nord de la Colombie-Britannique, le Saumon Quinnat est l'espèce la plus diverse pour ce qui est des variations du cycle de vie mais c'est aussi la moins abondante et celle qui fréquente le moins de cours d'eau. Les variations observées au niveau du cycle de vie comprennent notamment des périodes plus ou moins longues de grossissement des jeunes saumons en eau douce, des décalages temporels dans les remontes et des différences de taille ou d'âge pour la maturité sexuelle des adultes.

Dans le Centre de la Colombie-Britannique, les saumons Quinnat ont été observés dans 30 cours d'eau mais les effectifs d'échappée moyens ne dépassent 100 géniteurs que sur 9 d'entre eux. Numériquement parlant, c'est les remontes dans le système de la rivière Bella Coola, notamment dans la rivière Atnarko et dans la rivière Snootli Creek et son écloserie, qui dominent l'écologie du Saumon Quinnat dans la région puisque l'effectif total de ces remontes est cinq fois plus élevé que celui observé sur le système classé second en importance pour le Saumon Quinnat. Dans le Nord, les saumons Quinnat fréquentent plus de cours d'eau (105 au total) et on les a observés de manière régulière dans près de 83 d'entre eux. Pour ce qui est des sous-secteurs du Nord, les îles de la Reine-Charlotte n'ont qu'une seule population de saumons Quinnat (dans la rivière Yakoun) et la rivière Skeena abrite environ 40 systèmes où les saumons Quinnat remontent. Le bassin intérieur de la Nass, les secteurs de la côte Nord et le bras Kitimat abritent cependant chacun près de 14 cours d'eau dans lesquels des saumons Quinnat ont été régulièrement observés. Les échappées de la plupart de ces populations ont décliné dans les années 1970 mais les tendances observées depuis les dernières années semblent dépendre de la date de remonte des adultes (les saumons Quinnat qui remontent le plus tôt sont plus affectés par la pêche), de l'intensité des activités de mise en valeur dans le système en question et du taux de survie en mer. L'effectif des échappées a augmenté pour de nombreuses populations du Centre et du Nord de la Colombie-

Britannique mais il reste des secteurs préoccupants qui devraient faire l'objet d'études plus détaillées.

Les efforts de dénombrement des échappées de saumons Quinnat varient beaucoup d'un secteur à l'autre. Dans la région du Centre, seuls neuf systèmes ont fait l'objet d'un recensement annuel en moyenne plus d'une année sur deux depuis 1950 et les méthodes utilisées dans certains secteurs n'ont pas été bien documentées. Les évaluations d'échappées les plus complètes sont effectuées dans le système de la Bella Coola et de l'Atnarko ainsi que sur la Dean. Dans le Nord, la grande majorité des relevés d'échappées se font visuellement et la fréquence de ces derniers a été plus satisfaisante que dans la région du Centre. Des efforts ont également été faits pour produire des estimations plus quantitatives. On peut par exemple citer le programme du Conseil tribal des Nisga'a visant à estimer la remonte des saumons Quinnat dans le cours supérieur de la Nass à l'aide de la technique de capture-marquage-recapture. Dans la Skeena, on compte les saumons Quinnat au passage de la porte de la Babine. Depuis 1984, le saumon Quinnat d'été de la Kitsumkalum est le seul stock indicateur pour le Nord. Les données provenant du stock indicateur de la Kitsumkalum ont été particulièrement utiles pour différencier l'évolution de la pression halieutique de celle du taux de survie en mer. Malheureusement, comme dans le cas du Saumon Coho, l'absence de stock indicateur (marquage des spécimens) pour les saumons Quinnat du Centre de la Colombie-Britannique limite sérieusement l'évaluation de l'impact des pêches et de l'évolution de la survie des populations dans cette région. Par ailleurs, les réductions budgétaires continues du ministère se traduisent chaque année par une diminution supplémentaire du nombre de cours d'eau surveillés. Certaines coupures ont entraîné des pertes importantes d'informations au cours des dernières années.

La mise en valeur du Saumon Quinnat dans les régions s'appuie sur les deux grandes écloseries de la rivière Snootli Creek et de la Kitimat et sur plusieurs programmes communautaires plus modestes. Les stratégies de mise en valeur et les lâchers de saumons Quinnat sont expliqués en détail dans ce rapport. Pour un grand nombre de systèmes, il est cependant impossible d'estimer l'effectif total des remontes des saumons d'élevage car l'on ne dispose pas de suffisamment de données sur les échappées vers les frayères.

1.0 INTRODUCTION

In October 2002, the Pacific Fisheries Resource Conservation Council (PFRCC) published an in-depth description of Pacific salmon in southern British Columbia, including sockeye in the Okanagan River[3]. That report was the PFRCC's first step in describing the Pacific salmon resource in British Columbia and Yukon, its current state, and the ability to assess and understand this important resource. That report is available from the PFRCC office or the website (www.fish.bc.ca).

This second report in the series covers Pacific salmon in central British Columbia north to the Nass River and Portland Canal. A third report on Pacific salmon in the northern transboundary rivers and the Yukon River will complete the Council's overview of Pacific salmon.

There are thousands of Pacific salmon populations in British Columbia and the Yukon. The Council's challenge has been to summarize the available material into informative text that can be used by interest groups and the public for future reference. In developing this report, the Council has attempted to present a balance of comments and observations that include the details of the resource base, the status of salmon today compared to past years, and the management and monitoring of these populations. Public attention is frequently focused on the immediate salmon crises, reduction in fisheries, and negative circumstances associated with salmon. **Salmon are indeed threatened by continued economic development, climate change, and human population growth. At the same time, Pacific salmon continues to be a diverse, highly dynamic and resilient group of species.** An overly narrow focus on negative circumstances does not benefit the conservation of salmon or fisheries. A more appropriate perspective should consider the full breadth of information and present a long-term perspective on the status of salmon populations while also identifying the problems, challenges and opportunities.

The information in this report is derived primarily from records of the numbers of salmon spawning obtained from Fisheries and Oceans Canada, reports reviewed and accepted by the Pacific Scientific Advice Review Committee (PSARC[4]), and published references.

The Council expects that this series of three reports will be the basis for evolving documents that incorporate new information and identify conservation issues as they develop. The Council's website provides the medium for maintaining these reports and obtaining feedback from interest groups. Numerous staff from Fisheries and Oceans Canada assisted in providing data, explanations, and mapping services. Dr. Isobel Pearsalli provided invaluable assistance in creating a Microsoft Access database of the salmon spawning escapement data.

1.1 Report Description

The first report in this series was contained in the Annual Report 2001-2002 of the Council. It included the description of the salmon resource in southern British Columbia, the Fraser River, and the Okanagan River, plus Council comments on other issues. The Council recently decided to issue advisories, such as these salmon resource reports and other issues, separately from their required annual reports. The Council's advisories are now issued at various times throughout the year. Therefore, this second report differs slightly from the portrayal contained in the Annual Report 2001-2002. The content of this report is limited to the salmon resources of central and northern British Columbia, monitoring programs for those resources, and current salmon issues in these regions.

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[3] PFRCC Annual Report 2001-2002. PFRCC, 590-800 Burrard Street, Vancouver, BC. V6Z 2G7. Phone: 604-775-5621 or Fax 604-775-5622

[4] www-sci.pac.dfo-mpo.gc.ca/sci/psarc

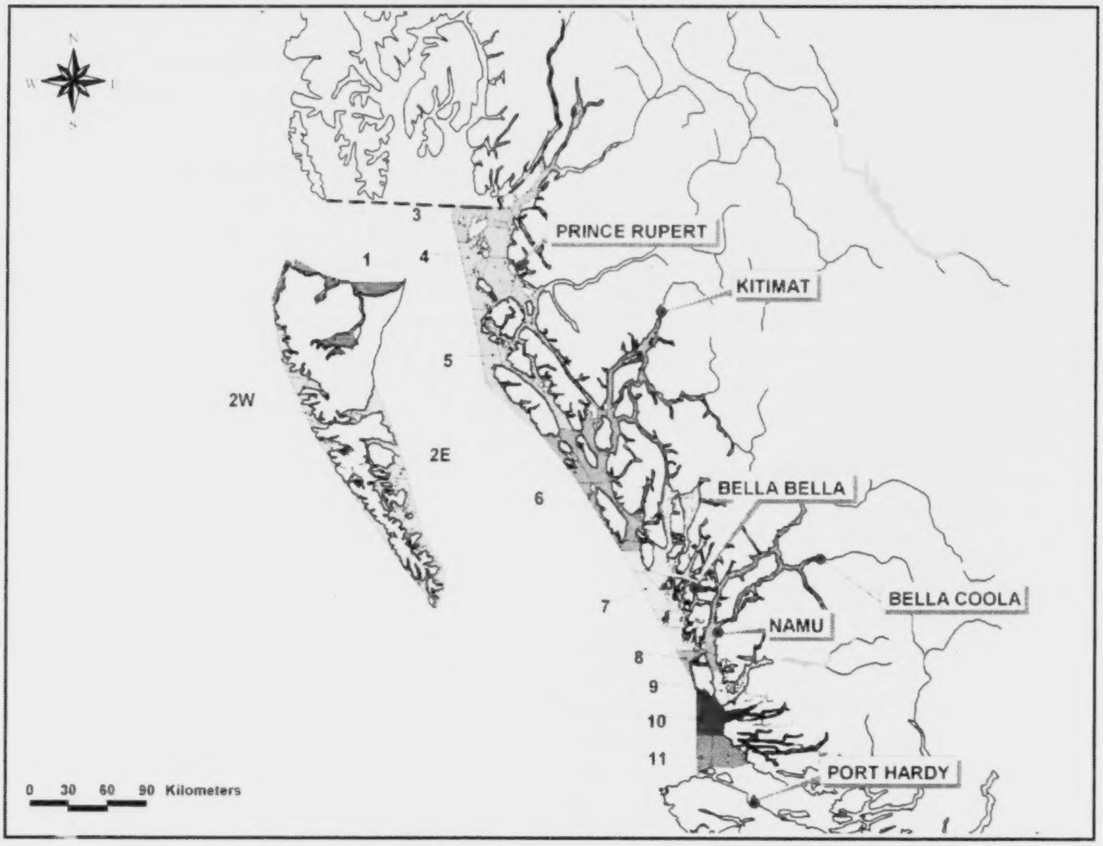
This report is limited to salmon in the geographic central coast of British Columbia and associated coastal rivers. Our definition of the central coast does not correspond precisely with the boundaries of the statistical areas defined by Fisheries and Oceans Canada. For the most part, this report deals with the management areas of northern BC (statistical areas 1 to 6) and central BC (statistical areas 7-11) (see Map 1). The current delineation of central BC by Fisheries and Oceans Canada also includes statistical areas 12, 13 and 27 (upper Vancouver Island and Johnstone Strait) but these areas were included in our previous report on southern BC.

Descriptions of the salmon locations in this report refer to central BC (as a whole or may refer to specific statistical areas) and five sub-areas within northern BC. Central BC is discussed as one unit since the other identifiable geographic units were discussed in the Annual Report 2001-2002. In northern BC, there are obvious geographic units that can be identified and spawning escapements aggregated within them. These five geographic units are: Queen Charlotte Islands (statistical areas 1, 2E, and 2W), interior Nass River (statistical area 3B), interior Skeena River (statistical areas 4B, 4C, and 4D), Kitimat Arm (statistical area 6), and a combined area of the outer coast, referred to as North Coastal (statistical areas 3A, 4A, and 5). In some tables and text, specific locations are used to locate salmon populations. The most commonly used locations are shown in Map 2.

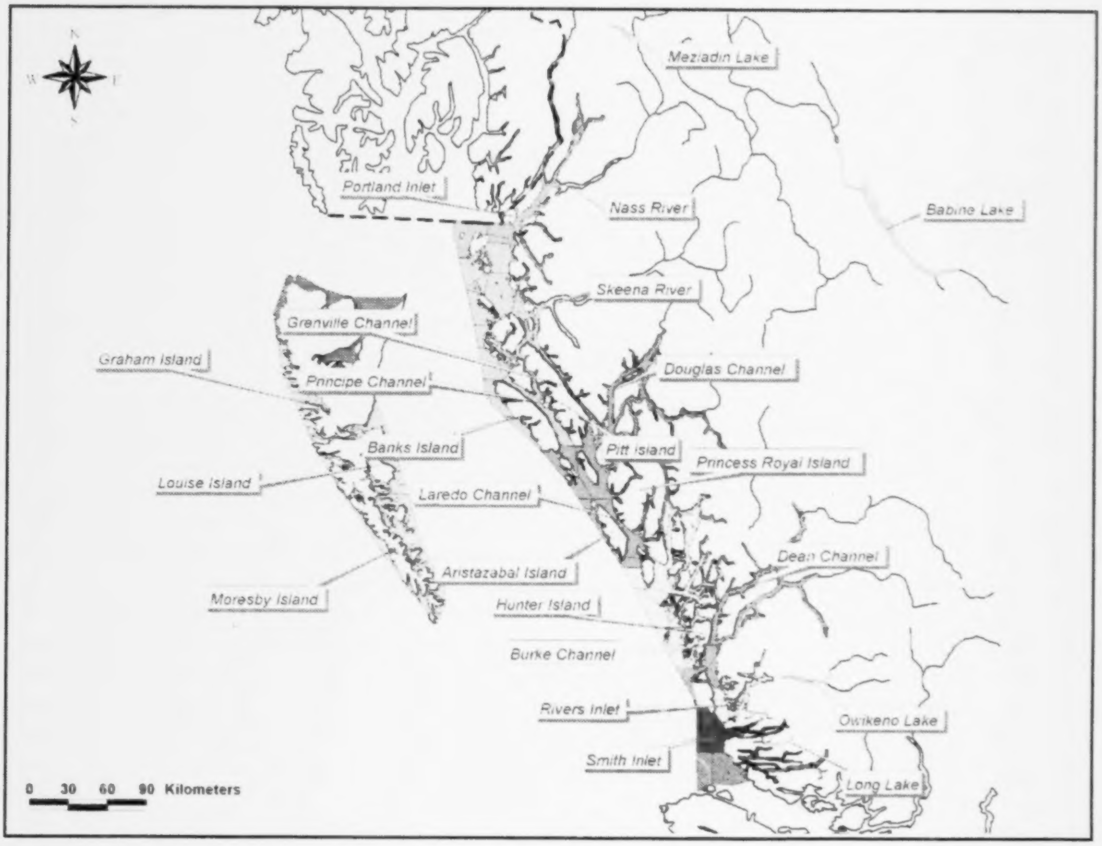
Our previous report was organized on the basis of major geographic areas that had different balances of species and issues. This report, however, has been organized by species over the geographic areas, and then by issues within those areas. The basic data are numbers of spawning salmon from 1950 to 2002 (53 years). Data previous to 1999 or 2000 were from Fisheries and Oceans Canada databases, and data after that period were acquired from the local management or assessment staff. Most of the spawning escapement data was based on visual estimates of the number of spawning salmon. Over time fisheries officers and scientists have derived these visual data via different methods in different areas, often changing their procedures over time. The accuracy of any observation is *unknown* unless it is determined from quantitative assessment programs (e.g. counts of salmon at fences or based on mark-recapture studies). Typically though, the data are treated as reasonable measures of the trend in salmon spawning status through time. The analyses presented in this report use the data as reported in the spawning records, unless a species is rarely observed in a stream (i.e., ≤5 observations in total) and these rare observations are typically for less than 25 to 50 fish. Escapements in streams or areas are summarized within decades, and averaged for 2001 and 2002, unless detailed plots are provided for a species and stream over all years of recorded data.

Map 1. Statistical area designations used by the Fisheries and Oceans Canada and towns in central BC (areas 7-11) and northern BC (areas 1 – 6).

Detailed electronic maps are available at: www.pac.dfo-mpo.gc.ca/ops/fm/Areas/areamap_e.htm



The Council must caution, however, that the absence of a recorded escapement value for a species in a stream and year may not indicate that the species does not use the stream, nor does it imply extinction from a stream. It may simply reflect that the frequency of stream surveys and visits within a stream has declined in recent years. Fisheries and Oceans Canada staff will enter a value for escapements in streams that have been observed, but they have an option of using non-numeric codes that cannot be easily incorporated into this trend analysis. For example, a species may be present but the inspection recorded as: N/O (inspected but none observed), PST (species was present), or UNK (inspected the stream and species present but no estimate of escapement). If a stream was not inspected, it may have been designated as N/I (not inspected) or N/R (no record of any type for the stream). Only numeric entries are used in this assessment but N/O, PST, and UNK entries are counted when assessing the frequency of stream surveys.



Map 2. Location of islands, lakes, and marine channels used in this report.

The Council also notes that two other substantial reports have recently presented material similar to this presentation. Readers may also wish to reference Gottesfeld et al. (2002) for details of Skeena River fish populations and their habitats and Harvey and MacDuffee (2002) for salmon and their ecological role in northern and central BC.

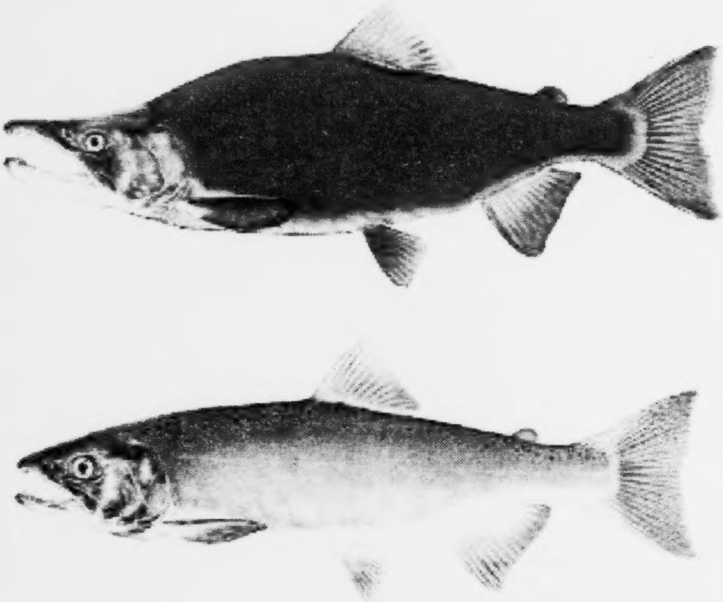
1.2 Use of "Uncertainty" in the Text

Many people will understand what uncertainty means in normal English usage. In this context, however, uncertainty is used in a statistical sense and means a lack of confidence or the variability about a number or estimate of a value. In normal usage, uncertainty implies doubt. The concept is not very different in this report, but in a statistical sense uncertainty can sometimes be quantified if sufficient data are available. Uncertainty may be represented by the variance of an estimate (e.g., variability about an average value), or by a range of possible values if alternative methods are used, or may simply be knowing the direction of an error but the magnitude is unknown (i.e., a bias). In this text, uncertainty can most commonly be interpreted as doubt about the accuracy of a value.

2.0 SOCKEYE SALMON (*ONCORHNYCHUS NERKA*)

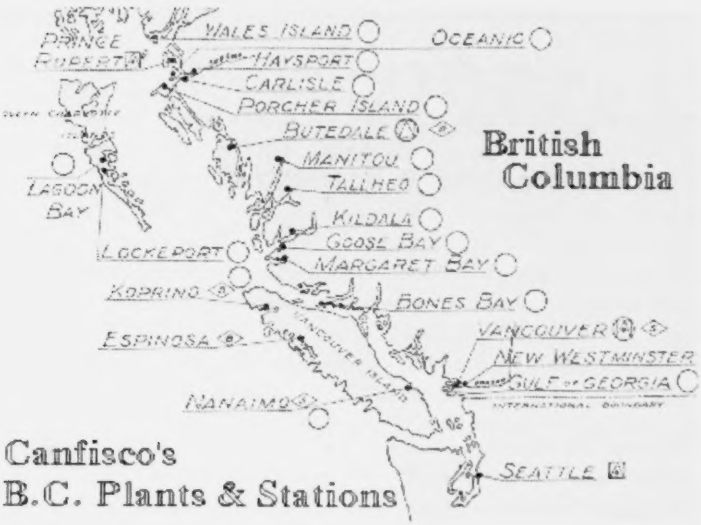
Sockeye salmon in central and northern British Columbia consist of a diverse mixture of those in a few large lake systems, others in the numerous smaller lake systems along the coast and in the interior, and some stream-rearing populations. For millennia, these sockeye have provided food for the First Nations and nutrients to the freshwater ecosystems. But since the late 1800s, sockeye salmon have also been an important economic resource as salmon canneries developed throughout central and northern areas.

Mature colours of Sockeye salmon



The canneries were not only located on the large rivers, such as the Skeena, but were distributed from Rivers Inlet north to the Nass River, and the Queen Charlotte Islands. For example, a map prepared for the Canadian Fishing Company shows 13 canneries for just this one company. These canneries were developed to not only process sockeye salmon; but the expansion north from the Fraser River was largely to locate new sources of sockeye salmon. This was particularly the case during the early 1900s as competition with trap nets for Fraser sockeye salmon limited Canadian access to these fish, and then when the Hells Gate slide (1913-1914) reduced Fraser sockeye production. [(www.canfisco.com) Canfisco provides an excellent website for historical information on the Pacific salmon canneries.]

Canfisco's B.C. Plants and Stations



The life cycle of sockeye salmon usually requires that a spawning population be associated with a lake for rearing the juveniles. Shortly after emerging from the gravel, the juveniles move into the lakes to rear for one to two years before emigrating at the smolt stage from the lake downstream to the ocean. Sockeye normally make limited use of the estuaries and move rapidly northward along the coast, and then out into the open Pacific Ocean to rear for another one to three years. Once mature, the adults migrate back to spawn and start another cycle of production; they are renowned for their abilities to home to their spawning tributary. Depending on the geographic location of the spawning stream, adults may migrate into freshwater from late spring to early autumn.

Sockeye salmon in the central and northern regions are commonly associated with four large lake systems (Long Lake, Smith Inlet; Owikeno Lake, Rivers Inlet; Babine Lake, Skeena River; and Meziadin Lake, Nass River; Map 2). These lakes account for the vast majority of sockeye salmon production in this region, but they are only a small component of the diversity of spawning populations along the coast and in the large rivers. In the coastal zone from Statistical Area 11 north to Area 3 (Portland Canal) and the Queen Charlotte Islands (QCI, Areas 1, 2E, 2W), this report documents about 110 other sockeye populations, plus an additional 7 in the Nass River and 27 in the Skeena River watershed. The exact number of these populations depends on the criteria used to define a distinct salmon population. In many cases, limited observations indicate that sockeye salmon may be present in local streams, but whether they represent a local spawning and rearing population is frequently unknown. We do know, though, that the four major sockeye systems are not representative of the diversity of other sockeye in this region. In total, sockeye salmons in this region have been an invaluable resource for First Nations, commercial fishers, shoreworkers and local residents (e.g., Figure 2.1, 1952 - 2002).

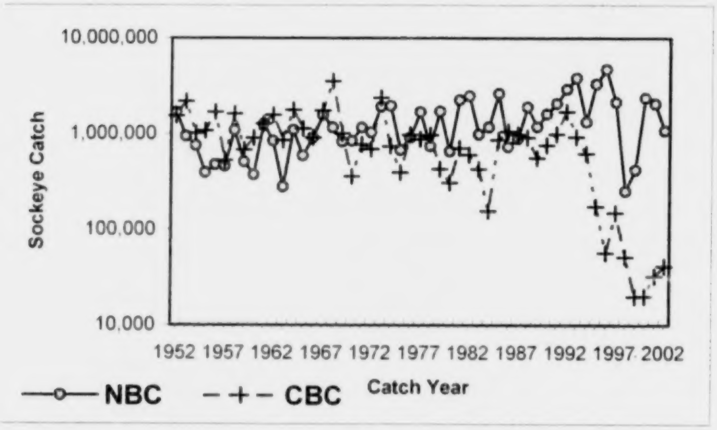


Figure 2.1. Commercial catch of sockeye salmon in northern BC (NBC areas 1-5) and central BC (CBC areas 6-11).

Northern fisheries are largely directed on production from the Babine and Meziadin lake systems, and fisheries in central BC on production from Owikeno and Long lakes. Catch is expressed in total number of sockeye salmon recorded in Departmental catch statistics.

The diversity of sockeye populations and the variability in data quality between various populations, make it difficult to determine a simple means to summarize the overall status of this resource. The sockeye river system that has been most thoroughly investigated is the Skeena River including Babine Lake. Consequently, the Skeena sockeye populations are discussed first, and then the coastal populations, QCI, and Nass River populations. To present this information as concisely as possible, we have made extensive use of summary tables and graphs for many of the small populations. The trends in these populations are difficult to describe briefly, so visual presentation of the data is used here as a means to portray them. In summarizing the trends and status in these many populations, we have adopted a descriptive scale that compares the numbers of sockeye estimated to be spawning in a system in recent years versus the numbers that were estimated in an earlier time period. The 'early period' will vary between lakes depending upon the date that information was first available.

Sockeye Assessment Scale: Current status is defined as the period during the past decade. It is compared against the escapements recorded during the 1950s and 1960s (i.e., the base), depending upon the availability of escapement data for each population. The following criteria were used to summarize these assessments:

- Increasing escapements … current period is more than 25% larger than the base.
- Stable escapements … current period differs less than 25% (+ or -) from the base.
- Decreasing escapements … current period is less than 75% but more than 25% of base.
- Depressed escapements … current period is less than or equal to 25% of the base.
- Unknown (1) … sockeye present, but data are inadequate for an indication of status.
- Unknown (2) … sockeye present, data were available for the early period, but annual surveys have been stopped or recent surveys are inadequate to provide an assessment.
- Unknown (3) … periodic observations of sockeye present in a system but data are too fragmented to suggest a local sockeye population.

These definitions are subjective, but the intention is to provide a concise and consistent interpretation of the available information. Simple comparison of present data with past data has many limitations. For example, we have not reviewed the methods used in assessment over time, nor have we accounted for the numerous changes in fishing pressures or land uses. The intention is to present the diversity of sockeye populations in central and northern coastal regions and to indicate the state of the spawning populations in them. Any further investigation of stock production dynamics or ecosystem impacts due to habitat changes, for instance, would require a more in-depth review than is intended in this presentation. Readers are referred to the citations at the end of section 1.2 for more detail on these issues.

2.1. Skeena River Sockeye Salmon[5]

Skeena River sockeye lakes are distributed from the coast to the high interior regions. They vary in size and production. The interior Skeena region has one very large sockeye rearing system (Babine-Nilkitkwa lakes) and approximately 27 smaller lakes. Johnson Lake and the Ecstall River in the lower Skeena River are included in considerations of the north coastal sockeye populations. Babine Lake comprises about 71% of the total Skeena sockeye rearing area (Shortreed et al. 1998). Babine Lake was enhanced in the late 1960s and early 1970s with the development of the Pinkut Creek and Fulton River spawning channels. Tagging studies (Smith and Jordan 1973) identified three distinct runs of sockeye into Babine Lake (early, mid, and late-timing). Wood et al. (1998) concluded that these runs were sub-populations rather than distinct populations because they are connected by relatively high rates of gene flow. Wood et al. (1998) provided the most recent assessment of sockeye production dynamics in Babine Lake.

In addition to Babine Lake, ten other Skeena nursery lakes are considered important sockeye producers: Alastair, Bear, Johanson, Kitsumkalum, Kitwanga, Lakelse, Morice, Morrison, Sustut, and Swan (Shortreed et al 1998). These ten lakes comprise about 25% of the total Skeena sockeye rearing area (Shortreed et al 1998). There are also 17 other smaller Skeena lakes that are utilized by juvenile sockeye: Aldrich, Asitka, Atna, Azuklotz, Club, Damshilgwit, Dennis, Kluatantan, Kluayaz, McDonell, Motase, Sicintine, Stephens, Slamgeesh, Spawning, Maxan, and Little Bulkley. These smaller lakes comprise about 3-4% of the total Skeena nursery area (Shortreed et al. 1998). Several of the smaller lakes are part of larger lake and river systems within the same drainage.

Most Skeena sockeye salmon migrate seaward from April through June predominantly as age-1 smolts having spent one year in the rearing lakes. Some populations have significant proportions of age-2 and some age-3 smolts (e.g., Morice Lake). Most returning adults are age-4 or age-5 and pass through southeast Alaska waters and into the Skeena fishing areas from mid-June through late August. Since populations differ in migration timing, fisheries can differentially impact them. At present, fisheries are primarily directed on the productive mid-timed Babine enhanced component (peaking in the third week of July). Generally, spawning takes place in lake tributary streams and along lake shorelines from late August through early October.

Visual escapement data for Skeena sockeye lakes have been collected since the late 1920s in some locations. McKinnell and Rutherford (1994) carried out an extensive review of methods for estimating non-Babine sockeye. The accuracy and the precision of visual sockeye escapement data to the smaller Skeena River sockeye lakes are variable and uncertain because of the wide variety of measurement methods. Escapement estimates to most of the smaller Skeena lakes have been conducted either by foot or air surveys. Fence counts are (or have been) available for some lake systems: from 1962-1967 in Williams and Scully Creeks (tributaries to Lakelse Lake); from 1992-present in the Sustut River below Sustut and Johanson lakes; from 2000-present in the Kitwanga River below Kitwanga Lake; from 2001-present in Slamgeesh Lake, in 2001 in Swan Lake; and in the Babine River below Nilkitkwa Lake since 1946.

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[5] An in-depth assessment of Skeena sockeye (non-Babine) lakes was prepared by Cox-Rogers, Hume, and Shortreed (DFO) for the May 2003 meetings of the Pacific Scientific Advice Review Committee (PSARC). This text is largely derived from their material. Also see DFO Stock Status Report 2003/047.

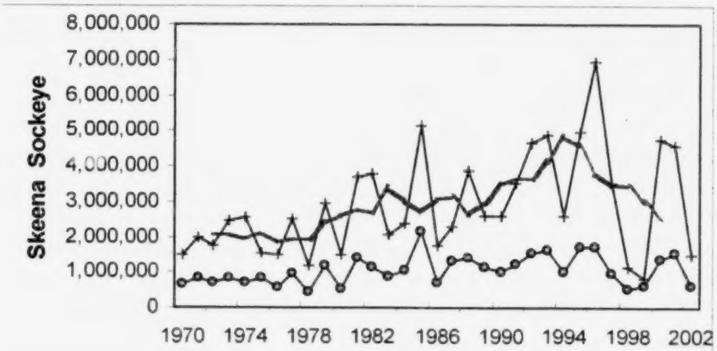
Shortreed et al. (1998) conducted trophic (i.e., studies of nutrients and lake productivity) assessments for the ten larger non-Babine nursery lakes in the mid 1990s and continued this work for additional Skeena nursery lakes in 2001 and 2002. Most of these lakes are oligotrophic (poor in nutrient for biological production) and presently produce sockeye below the lakes' production potential (Shortreed et al. 1998). Factors limiting sockeye production from the non-Babine lakes range from glacial turbidity (Kitsumkalum Lake) to extremely low nutrient levels (Morice Lake) (Shortreed et al. 1998, 2001). Similar but earlier assessments of lake rearing capacity led to the development of two Babine Lake tributaries (Fulton River and Pinkut Creek) into two of Fisheries and Oceans Canada's largest salmon enhancement programs.

West and Mason (1987) provide an excellent review of the Babine Lake Development Project (BLDP). It resulted from early research by the Fisheries Research Board of Canada that had begun surveys of Babine sockeye populations in the mid-1940s. That research lead Brett (1952) and Johnson (1958, 1961) to suggest that Babine Lake was capable of supporting much larger numbers of sockeye juveniles than were entering the lake. The resulting project had a target of increasing fry entering the lake by 100 million fry annually. In the report by West and Mason the following is noted:

> *"The BLDP associated with this production target presently consists of two spawning channels at Fulton River, one spawning channel at Pinkut Creek, and associated river flow control structures on each system. Channel no.1 at Fulton River became operational in 1965. Pinkut channel in 1968, and Fulton Channel no.2 became operational in two stages, in 1969 and 1971. River flow control structures and permanent adult and fry counting fences were completed in 1968....*
>
> *The BLDP production target was established on the assumption that fry of river and channel origins were equally viable. It was anticipated that the 100 million additional fry would provide some 30 million smolts and 1.25 million adult sockeye, of which 1 million could be harvested in the commercial fisheries."*

Generally, most people believe that the BLDP has been a success and indeed the total return of Skeena sockeye has increased since the early 1970s (Figure 2.2). On an economic basis, West and Mason (1987) estimated a benefit/cost return for the BLDP of 3:1 by the mid-1980s.

Figure 2.2. Estimated total production of Skeena River sockeye salmon and total escapement of sockeye to the Skeena River spawning populations.



The crosses (+) indicate total production including all catches in SE Alaska and northern BC and spawning escapements. The circles are the spawning escapement estimates for all Skeena spawning populations. The gray line through the total production data is a 5-point smoothed line to indicate the trend in total production over time. (Data provided by S. Cox-Rogers, Biologist, DFO, Prince Rupert, BC).

The 'success' of the BLDP has created concerns for the other non-enhanced, non-Babine sockeye populations. For example, if 1 million of 1.25 million sockeye were caught (i.e., an 80% harvest rate), what would be the fishing impact on these other populations? Could the non-enhanced populations sustain this fishing impact? Expressing Figure 2.2 as a harvest or fishing rate (the percentage of total return taken as catch) indicates that the fishing rate has not increased notably over time (Figure 2.3), but this result does not consider whether the sockeye populations are equally productive and can all sustain this level of fishing.

In recent years extensive concern has been expressed about the status of the non-enhanced, non-Babine sockeye populations in Skeena River. To examine these concerns, we have reviewed the available escapement records for these lakes and their spawning tributaries. As noted above, these assessments are only based on the reported Fisheries and Oceans Canada spawning escapements to these systems. Table 2.1 summarizes the available data and our assessment of the current status of these different Skeena sockeye systems.

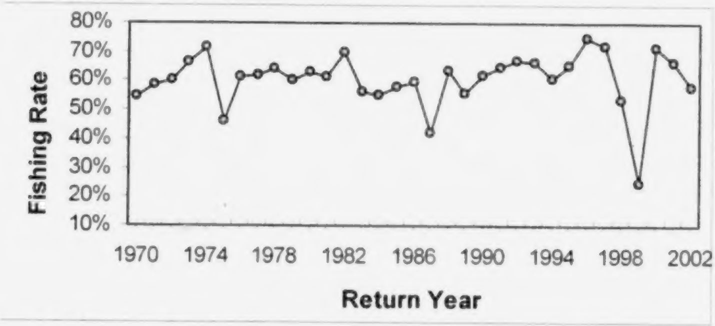


Figure 2.3. Annual fishing rate estimated for Skeena sockeye salmon based on data in Figure 2.2

The graphs associated with Table 2.1 are presented in Appendix A.

When considered at the river system level, the response of the non-Babine sockeye populations to the BLDP has been mixed and the patterns of spawning escapements differ between systems. Of the 13 non-Babine sockeye producing systems recognized in the Skeena watershed (assessment basis documented in Table 2.1), this review indicates: three systems increased relative to the average escapement recorded for the 1950-1970 period (i.e., pre-BLDP); one system was stable; three systems decreased; one system is depressed but the assessment is highly uncertain due to an absence of recent data; two systems could not be assessed due to an absence of base period data; and three could not be assessed simply due to a general lack of data at any time. Most of the systems show a decline in escapements and a subsequent recovery, but the timing of these declines is not synchronous, nor is the extent of decline equal.

Appendix A also includes plots of the sockeye escapement to the Babine River counting fence (outlet of Nilkitkwa Lake and counts all sockeye returning to the BLDP) and to Morrison Lake, a non-enhanced component of the Babine Lake system. The pattern to Morrison Lake more clearly exemplifies the pattern of declining escapements as the sockeye returns to the BLDP increased, but even Morrison sockeye show increased escapements in recent years.

These aggregate responses within river systems may also hide an impact on less productive spawning components of a system. However, to identify these will be difficult with the reduction in numbers of spawning tributaries that are assessed on an annual basis. The most immediate concerns for these non-Babine systems are for returns to the Bulkley and Maxan lakes, to the Lakelse Lake (but the changes in escapement surveys confound this assessment), and to Alastair Lake. Records of spawning escapements cannot be used to assess the current status of sockeye salmon returning to: Kitseguecla River, Kitwanga River, Kluatantan and Kuayaz Lakes, Sicintine River and Motase Lake, and Slamgeesh River.

2.1.1 Survival Rate for Babine Sockeye Smolts

Sockeye smolts leaving Nilkitkwa Lake have been enumerated annually since 1961 using a mark-and-recapture technique. The smolts leaving are the aggregate production from all Babine and Morrison Lake populations. The availability of these data, coupled with the monitoring of sockeye returns and age of returning adults, provides a unique opportunity to follow the downstream and marine survival of these sockeye salmon. The data and methods have been reviewed in a few key references (Jordan and Smith 1968, Macdonald and Smith 1980, Macdonald et al. 1987). The only other lake in central and northern BC where marine survival of sockeye smolts can be enumerated is at Long Lake (Area 10).

The smolt enumeration data are also useful in tracking the change in smolt production following development of the BLDP. Macdonald et al. (1987) presented data on smolt production and fry entering the lake for the 1959 to 1983 spawning years. About half of these years are before the BLDP. Their relationship between fry entering the lake and smolts produced one year later was essentially linear and the slope of the line (one to one) indicated an almost proportional increase in smolt production with increased fry into the lake. More recent data on smolt production were provided by the North Coast Management Program (S. Cox-Rogers, DFO, Prince Rupert, BC). As is evident in Figure 2.4, smolt production can be quite variable over time. The numbers of smolt produced depends upon spawning success, egg-to-fry survival, and then survival and growth of the fry in the lakes. For example, the smolt production for spawning years 1993 to 1995 (circled in Figure 2.4) was poor; this has been attributed to poor fry survival from the BLDP projects. The low number of smolts from the 1998 and 1999 spawning years reflects limited fry production due to the reduced return of spawners associated with the poor 1993 to 1995 smolt production.

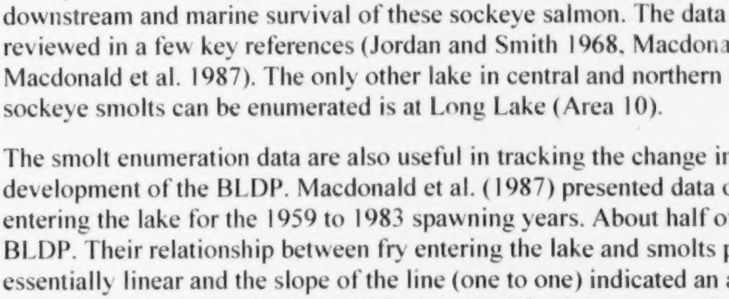


Figure 2.4. Estimated numbers of sockeye smolts emigrating from the Babine Lake complex by return (spawning) year.

The year of emigration from the lake is determined by adding two years to the Return year. Smolt production was not estimated for the 1987 return year.

Table 2.1. Sockeye salmon systems in the Skeena River (up-stream of Coastal Area 4A) and summaries of the spawning tributaries and status relative to years previous to the Babine Lake Development Program.

Periods used for comparison vary depending on the availability of early data.

System	Sockeye lakes	Number of spawning sites recorded	Average Escapement for early period	Escapement in recent period	Status and comments
Alastair Lake, Gitnadoix R.	Alastair	Three, survey records annually in two systems	1950-1970, 15,200 spawners	1993-2002, 6,400 spawners	Escapements **decreased** but increasing trend until 1999-2002 period (*see graph*)
Lakelse R & Lake	Lakelse	Eight, 3 to 4 usually observed annually, but infrequent records after 1996	1950-1970, 10,700 spawners	1987-1996, 5,500 spawners	Escapements **decreased** and seems much poorer in most recent years, but reduced survey coverage confounds any current assessment (*see graph*)
Kitsumkalum River	Kitsumkalum	Five, usually 4 to 5 surveyed annual before mid-1980s but only 1 or 2 per year since.	1950-1970, 3,050 spawners	1993-2002, 4,000 spawers	Escapements **increased**, only Kitsumkalum Lake recorded as major spawning site in recent years. (*see graph*)
Zymoetz River	Aldrich, Dennis, McDonell	Two, upper and lower Zymoetz River, surveys for both into mid-1980s, upper river until 1993, but then no records until 2002	1950-1970, 2,500 spawners	1985-1994 3,000 spawners	Escapements **stable** on average but highly variable and no data between 1995-2002. 2002 entry for Upper Zymoetz River was 3,500 (preliminary) (*see graph*)
Kispiox River	Club, Stephens, Swan	Nine spawning sites but two with annual surveys – Upper and Lower Club Creek	1950-1970, 4,000 spawners	1993-2002 7,100 spawners	Aggregate escapement quite stable over time, **increased** relative to base, but reduced survey coverage during the 1990s. (*see graph*)
Kitseguecla River	Kitseguecla Lake	Kitseguecla River and Kitsuns Creek, rare data entry	Only two years of sockeye recorded since 1950		**No assessment** possible
Kitwanga River	Kitwancool Lake	Kitwanga River, infrequent records but a fence was installed below the lake in 2000	Only data for 1960-1968, 200 to 400 sockeye	2000-2002 fence counts were 231, 221, and 978	Assessment is **unknown** due to limited data but recent data indicates a small population.
Kluatantan River	Kluatantan & Kuayaz lakes	Very limited observations of sockeye in these systems, only 3 entries since 1950 but lakes are in the extreme upper Skeena R.	Unknown	Unknown	Sockeye thought to be present but only 3 records since 1950. **No Assessment** possible.

System	Sockeye lakes	Number of spawning sites recorded	Average Escapement for early period	Escapement in recent period	Status and comments
Sicintine River	Motase Lake	Escapements recorded to Motase Lake only two years of records for Sicintine River	Very limited early data, 1970-1975 range of spawners was 33 to 3,000	Observations since 1987, range of spawners from 30 to 750	Assessment of long-term change is not possible due to limited base data, but population is small and more recent years have only 50 to 250 spawners. **Unknown**
Slamgeesh River	Slamgeesh & Damshilgwit lakes	Escapement records infrequent, fence installed in 2001	Only 4 records, 1964-1972, range of spawners 50-500	Only recent data for 2001 = 855 and 2002 = 324 (preliminary)	An assessment of long-term change is not possible due to limited base data, but population is likely small at this time. **Unknown**
Sustut River	Asitka, Azuklotz, Bear, Sustut, Johanson, Spawning	Eight spawning sites but only three consistently recorded (Azuklotz Creek, Salix Creek, and a fence on the Sustut River since 1992)	1950-1970, 5,800 spawners mostly attributed to Azuklotz Cr and Bear Lake	Several decadal averages have all averaged about 4,000 spawners	While this assessment is uncertain due to changes in the stream surveys, the escapement level has apparently **decreased**. (*see graph*)
Bulkley River	Little Bulkley and Maxan lakes	Upper and Lower Bulkley River and Maxan Creek	1950-1970, average spawners = 300 (range 50 to 1,500)	No current data, *highly uncertain assessment.*	While not able to actually assess due to absence of recent data, trend in the returns (*see graph*) indicates strong decline. **Depressed**
Morice River	Morice, Atna, plus several tributary lakes	Atna River, Morice Lake and River, and Nanika River (Nanika is the major spawning tributary)	1950-1970, average spawners = 10,000	Several decadal averages have averaged about 20,000 spawners	Recent **increased** escapements due to strong escapements during the early 1990s but escapements have declined recently and there is no data for 2002. (*see graph*)
Babine River at Babine Fence site	Nilkitkwa, Babine, Morrison	Babine River, 12 major spawning locations, plus 13 less frequent, and two major enhancement programs at Fulton River and Pinkut Creek	1950-1970, average count past fence = 528,000	1993-2002, average count past fence = 1,320,000	Major **increase** in returns largely due to spawning channels at Pinkut and Fulton sites (*see graph* of trend and text for discussion)
Morrison Lake	Part of Babine system	Morrison Lake and Creek, none enhanced component of Babine	1950-1970, average spawners = 13,000	1993-2002, average spawners = 13,500	Escapement trend assessed as **stable**, but reflects significant recovery from decline in the late 1970s and early 1980s. (*see graph*)

The total return to the Babine Lake complex is also a function of their survival downstream of the lake and in the ocean environment. The estimated survival rate for Babine Lake smolts, based on spawning years (as presented in Figure 2.4) has varied from under 1% to over 12% (Figure 2.5). The importance of being able to estimate freshwater and marine survival rates is graphically demonstrated by results for the spawning years 1994 and 1995. In Figure 2.4, these years were the lowest years of smolt production in the time series. But the adult returns from these two years were very different due to the downstream and marine survival rates. The spawning year 1994 (smolt emigration in spring 1996) suffered further decline due to a subsequent survival rate of less than 1%. The spawning year 1995 (smolt emigration in spring 1997) benefited from the highest recorded downstream and ocean survival rate (12.4%). The net effect of smolt production and downstream survivals is expressed in the return of adults to the Babine counting fence (Figure 2.6).

The returns from the 1995 spawning year were about ten times the 1994 spawning year (evident in the age structured data) but these differences become mixed with returns from other spawning years and do not show this difference in the adult return years. For example, the very poor 1994 spawning year return as adult fish in 1997 to 1999 (age 3 males to age 5 males and age 4 and 5 females). But in any one of those years, adults from other spawning years also return. In 1999 for example, the return to the Babine fence (Figure 2.6) includes adults returning from spawning years 1996 (age 3 males or Jacks), the 1995 spawning year with the record marine survival, and the 1994 spawning year with the poor overall survival.

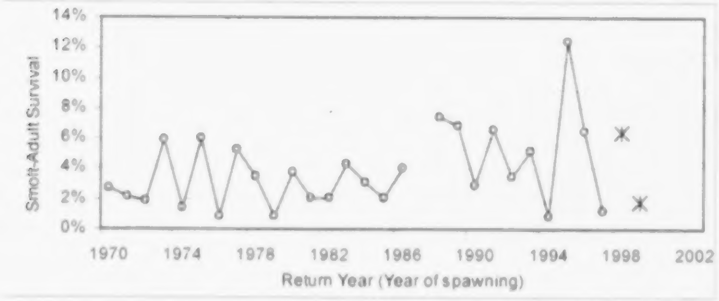


Figure 2.5. Estimated survival rate (% of smolt surviving to adult return) for Babine Lake sockeye smolts (1970 to 1999 spawning years).

Data for total returns from the 1998 and 1999 spawning years are incomplete, their survival rates were estimated based on historical relationships between age classes (, last two data points in this time series).*

A longer time perspective, since 1950, on trends in the Babine fence count has also been presented graphically in Appendix A. This longer-term plot shows more clearly the increasing trend in escapement returns from the late 1960s to the early 1990s.

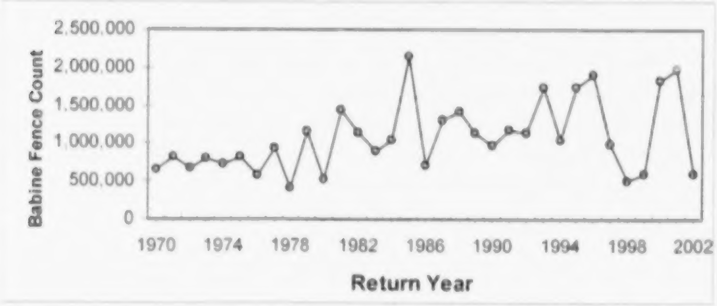


Figure 2.6. Total count of sockeye salmon returning to the Babine fence at the outlet of Nilkitkwa Lake (1970-2002).

Sockeye counted past the fence return to Babine and Morrison lakes and to the BLDP facilities. Returns from the poor smolts years (1993 to 1995 spawning years) would return to the Babine fence in years 1996 to 2000 depending on their age at maturity and return.

2.2 Coastal and Nass River Sockeye Populations

This section summarizes information on the spawning escapement of sockeye salmon to over 100 lakes from the Nass River south to Smith Inlet, including the Queen Charlotte Islands. Nass River sockeye populations have been included in this section since the numbers of systems is limited and can be summarized. Additional discussion is included concerning current assessment in the Nass River and sockeye production from Meziadin Lake. In order to summarize these data, tables of lakes by statistical area have been developed (Appendices B, C, D) and plots of sockeye escapement trends over time for many of the lakes are presented (Appendices E, F, and G). Plots are not provided for every lake system since many of the data series are limited or the plots are very similar to other nearby systems.

Over such a broad geographic range, it is not surprising that the freshwater environments used by these sockeye populations differ widely. They range from high interior lakes in the upper Nass River to complexes of small lakes on the coastal islands. The suitability of these lakes for sockeye production differs substantially, but investigations are being undertaken to assess this. An important paper on this issue is the Shortreed et al. (2001) report summarizing information on 60 lakes, including 42 in central and northern BC. The other feature of these populations is that some are known to be stream-rearing sockeye as opposed to the typical life history of rearing in lakes. Examples of stream-reared sockeye include the Tseax and Gingit Rivers in the lower Nass River and possibly the Kimsquit and Dean River sockeye in the central coast. Many coastal lakes apparently do not support sockeye salmon due to obstructions. Biological characteristics of these coastal populations are also quite different in both observable traits (i.e., such as growth rates and body size) and genetic traits (Rutherford et al. 1992, Nelson et al. 2003).

At this time, our review does not address differences in productivities or changes in freshwater habitats over time. This section provides an inventory of the lakes, their locations, and the trends in data availability and sockeye returns. A more detailed analysis may soon be possible as the provincial government is completing a database of all escapement records and numerous habitat variables by watershed. The Raincoast Conservation Society report provides some information on logging in watersheds (Harvey and MacDuffee 2002).

The primary concern for these numerous smaller sockeye populations was whether they were being over-fished due to interceptions in fisheries targeted on the larger sockeye lakes. The issue in northern BC centered on fisheries for Skeena and Nass sockeye and in central BC on fisheries for Rivers and Smith Inlet sockeye. Unfortunately, the task of enumerating all these lakes annually is very difficult and simply has not occurred. There have been periods of quite good coverage, particularly in the 1950s and 1960s, but generally the data have become more limited since the mid-1980s. There are, however, a number of lakes that have consistent annual records of escapement (without comment on the consistency of surveys over time or the accuracy of these surveys). With few exceptions, data on these stocks are based on visual counts of spawning populations. Table 2.2 summarizes the current status of the sockeye populations described in Appendices B, C and D and figures in Appendices E, F and G.

Table 2.2. Review of central and northern BC coastal sockeye stocks, excluding the interior Skeena River populations and the Owikeno and Long Lake populations.

This table summarizes the current status of the sockeye populations in Appendices B, C and D and figures in Appendices E, F and G.

Geographic Area	Increased	Stable	Decreased	Depressed	Unk (1)	Unk (2)	Unk (3)
Queen Charlotte Island (Areas 1, 2W, 2E)	1	3	3	2	0	1	1
Portland Inlet* (Area 3A)	0	0	0	1	1	0	0
Nass River (Area 3B)	1	2	1	2	2	0	0
Coastal Area 4A (lower Skeena)	0	2	1	0	0	0	0
Area 5, Banks and Pitt Islands	1	8	3	4	3	5	2
Area 6, Kitimat/Butedale	1	4	5	5	8	12	1
Area 7, Bella Bella	1	0	2	5	0	5	4
Area 8, Dean and Burke Channels, Bella Coola	0	3	1	3	1	0	3
Area 9, Rivers Inlet					1	0	0
Area 10 Smith Inlet & Area 11					0	0	2
Totals	5	22	16	22	16	23	13

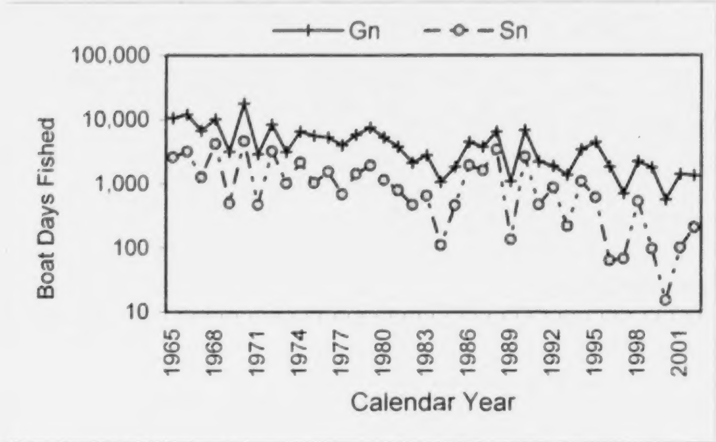
** Portland/Observatory Inlets ... several small lakes exist in the inlets but data on sockeye presence is very limited. Only two sockeye populations are noted in this review (Appendix B).*

The criteria used in the assessment are as described in Sockeye Assessment Scale (page 28). Since these assessments simply use the data as presented, plots of many of the lakes are included for inspection of trends over time. Table 2.2 also presents the assessments by geographic area since there are differences in the frequency of escapement surveys between different management areas. For example, a substantial number of sockeye lakes in Areas 5, 6 and 7 used to be assessed during the 1950s and into the mid-1970s, but many of these surveys are no longer conducted, precluding any current assessment of these populations (criteria: Unknown 2). Frequently, there will be a few observations in these lakes for the recent period, but there is little value in these observations given the wide variability in marine survival of salmon observed during the 1990s. If a population is described as Unknown some comment is made in the appendices concerning these recent observations (where this is possible).

Categories Unknown (1) and (3) indicate lakes where sockeye have been noted as present but the data are too limited to say much more. These 29 lakes indicate other *possible* sockeye populations. The remaining 88 lake systems represent the diversity of sockeye populations spread through central and northern BC's coastal zone, particularly in Areas 5 to 7.

By geographic area the assessment indicates that 47% of the sockeye systems in coastal Areas 1 to 4A are currently Stable or Increasing relative to their base period, while 53% have declined (5 of 19 were classified as Depressed). In the coastal islands of Area 5, Kitimat (Area 6) and central BC (Areas 7-8), 39% have maintained or increased the number of spawners compared to base levels, and 61% have declined (17 of the 46 systems were classified as Depressed). Overall one-third of these systems (22 of 65 stocks with data) have declined in spawning escapements to less than 25% of the escapements in their base years. These declines are particularly of concern given the recent reductions in fishing pressures, particularly in the central coast (Figure 2.7) and the expected increase in spawning numbers that would have been expected.

Figure 2.7. Number of total days fished in Areas 6,7 and 8 by gillnet (GN) and seine (SN) gears.



Data are for June and July only as these months are more likely directed to sockeye salmon. Data are from Salmon Catch Database at the Pacific Biological Station, Nanamio, BC. Data for 1965 (first year of effort data) to 2002.Since comparisons of escapement over time ignored these changes in fishing effort and catch, the degrees of change noted above are very likely a conservative assessment of the actual decline in total production of sockeye salmon over this time period.

2.2.1 Meziadin Sockeye Salmon[6]

Sockeye returns to Meziadin Lake and its spawning tributaries represent the majority (77%) of the sockeye salmon returning to the Nass River basin (Figure 2.8). Sockeye returns to Meziadin Lake are estimated accurately by counting fish through a fishway in the Meziadin River. Escapements to most other lakes in the Nass River have typically been estimated by visual surveys. However, since 1992, the total return of sockeye salmon into the upper Nass River (i.e., above the canyon) has been estimated by a mark-recapture program conducted under the Nisga'a Treaty agreement. Assessment of sockeye in the lower Nass, however, had been less rigorous until some recent fence programs were initiated.

Total production of Nass River sockeye salmon was stable during the period 1970 to 1990, but has increased in the past decade (Figure 2.9). This recent increase in total returns, however, has also resulted in a notable increase in the harvest rate on these Nass sockeye salmon.

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[6] Most recent assessment report is: Bocking, R.C. et al. 2002. Meziadin Lake biological escapement goal and considerations for increasing yield of sockeye salmon (*Oncorhynchus nerka*). CSAS Res. Docu. 2002/124.

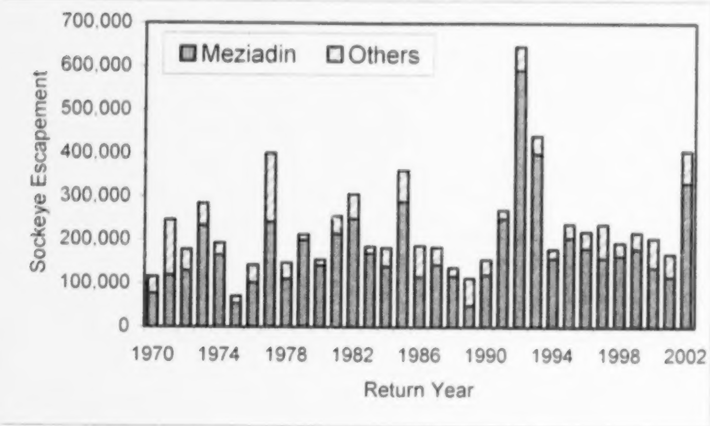


Figure 2.8. Total sockeye spawning escapement to the Nass River basin (1970-2002).

Total escapement in a year are cumulative with the return to Meziadin Lake on the bottom and returns to all other populations added on top.

Based on the data provided for Figure 2.9, recent harvest rates (percentage of the total return taken as catch) increased to between 70 and 80% during the 1990s (Figure 2.10). These levels of harvest would generate concerns for the status of less productive sockeye populations in the Nass River, but may be sustainable if marine productivity was high during that period. However, with 50% of the Nass populations being assessed as decreasing or depressed for recent escapements (Table 2.2), these trends merit some concern (particularly for the stream-rearing populations in the lower Nass River).

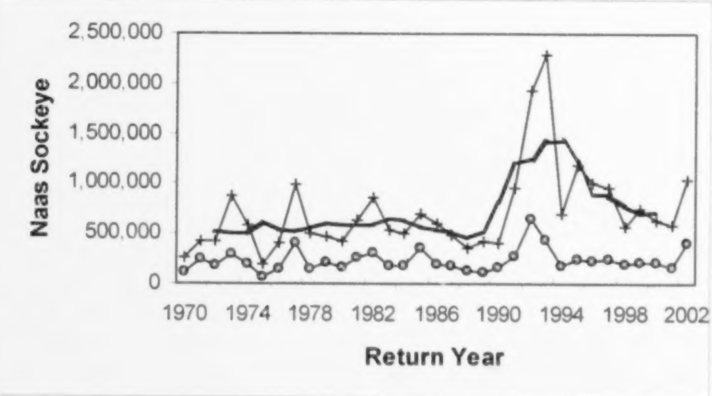


Figure 2.9. Estimated total production of Nass River sockeye salmon and spawning escapement of sockeye to the Nass River (1970-2002).

The crosses (+) indicate total production including catches in SE Alaska, northern BC, and spawning escapements. Circles are the total estimated spawning escapement for all Nass sockeye populations. The line through the total production is a 5-point smoothed line to show the trend in production over time. (Data from S. Cox-Rogers, Biologist, DFO, Prince Rupert, BC).

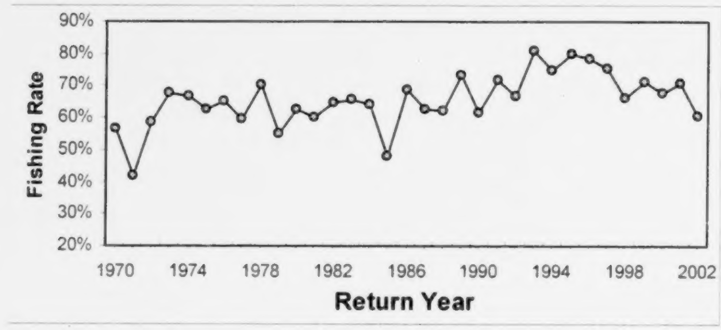


Figure 2.10. Annual fishing (or harvest) rate on Nass River sockeye salmon based on the total return and escapement data provided for Figure 2.9.

2.2.2 Queen Charlotte Islands

Sockeye salmon on the Queen Charlotte Islands have been observed in nine lakes noted in Appendix B, plus the Mamin River and Pallant Creek. Sockeye in the latter two systems have only been sporadically recorded and may not have ever been self-sustaining populations. Escapement records have also been noted in Tasu Creek, Deena River, and Lagins Creek but these records are so sporadic and generally very small (i.e., a few to tens of fish) that they are not recorded as sockeye systems in Appendix B.

The known sockeye populations on Queen Charlotte Islands are notable for differences in run timing and genetic composition. Timing of adult sockeye returns to some of these systems is exceptionally early for coastal sockeye (returns may occur from May through June). The region is also notable as the islands likely constituted one of the few lowland refuges during the last glaciation (Warner et al. 1982, Pielou 1991). Whether the area provided a refuge for Pacific salmon is unknown but certainly possible.

Several of the sockeye lakes on Queen Charlotte Islands have also been studied and treated with nutrients as part of Fishereis and Oceans Canada's Lake Enrichment Program. Stockner (1987) describes the basis of this program, but the objective is to provide nutrients to lakes in order to increase the biological productivity of the lake and to increase the size and survival of sockeye juveniles rearing in the lake. Shortreed et al. (2001) describe each treated lake (Awun, Ian, Mercer, Naden, and Yakoun) and the years treated. Treatments occurred between 1979 and 1985 but did not occur in each lake, each year. The response to lake fertilization, though, is "site specific and dependent upon each lake's community structure and incipient nutrient levels" (Stockner 1987, page 213). In these examples, the response in sockeye escapements in the 1980s was not particularly evident for these five lakes. The spawning escapement of sockeye to each of these treated lakes is presented graphically in Appendix E. A more appropriate assessment of these treatments would involve examination of the community responses, size and survival of juvenile sockeye, and the potential for catches to obscure the response in sockeye spawning escapements.

2.2.3 Outer Coastal and Central BC

The summary of sockeye lakes in Table 2.2 accounts for 93 sockeye lakes in the coastal zones of Area 3A, 4A, 5, Kitimat (Area 6), and Areas 7 to 11 (see Map 1). These areas account for the majority of coastal sockeye systems in this report, and all of the systems categorized as Unknown (2), with the possible exception of the Mamin River. That category refers to systems where data were available for earlier periods, but annual surveys have been stopped or recent surveys are inadequate to provide an assessment. Unlike the other Unknown categories, we include Unknown (2) systems as sockeye populations that simply do not have adequate data for assessment. Over half of these Unknown (2) systems occur in outer Area 6 Aristazabal Island. Unfortunately, of the 93 sockeye lakes included in Table 2.2, half of them do not have sufficient data for a current assessment or to confirm that they are an actual population (at least based on escapement records).

Table 2.2 though does not include the two largest sockeye lakes, Owikeno (Area 9) and Long (Area 10) in central BC. Sockeye salmon in both of these systems are presently recovering from a period of extremely poor marine survival in the mid-1990s, but in past times have been important to the First Nations and development of the central coast.

2.3 Owikeno Lake Sockeye

Owikeno Lake, at the head of Rivers Inlet, is large and connected to the inlet by the short Wannock River. Sockeye production from the lake has historically supported major commercial fisheries and their historical catch has been reconstructed from records of salmon cases packed (Argue and Shepard 1984). This stock had for most of the past century supported a commercial fishery of 500,000 to 1.5 million sockeye per year until sockeye returns became much more variable in the 1970s (Figure 2.11). During the 1980s and up to the fishery closure in the 1990s, an adaptive management plan was developed to provide stock assessment information and ensure protection when returns were weak.

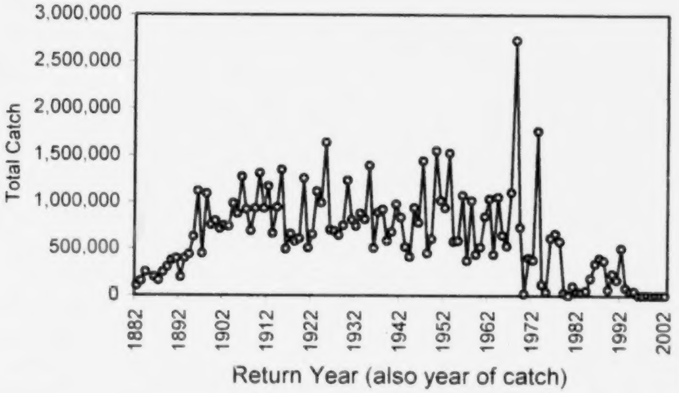


Figure 2.11. Estimated commercial catch of sockeye salmon in Rivers Inlet from 1882 to 2002.

Data from Argue and Shepard, 1984.

Sockeye spawning populations in Owikeno Lake have been recorded in eleven tributary streams and the lake itself (escapement data is available since 1948, see Rutherford and Wood 2000). Enumeration of sockeye spawners in Owikeno Lake is notoriously difficult and uncertain due to glacial turbidity in several of the larger spawning tributaries. Rutherford and Wood (2000) discuss how this problem has been dealt with in stock assessments. Annual estimates of spawning escapement are available, though, and provide the basis for an estimate of the total production of sockeye annually (Figure 2.12), not just catch as in Figure 2.11.

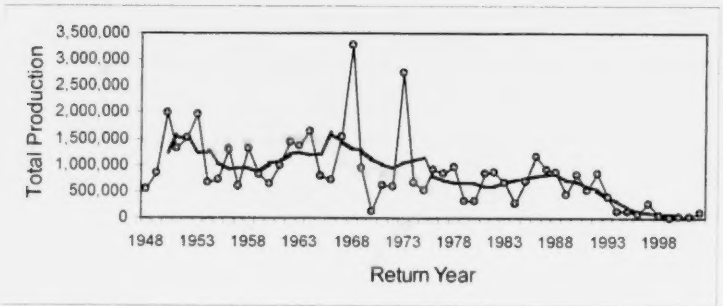


Figure 2.12. Total production of Owikeno sockeye salmon by year of return, based on estimated total catch and spawning escapements to the total Owikeno Lake system.

The smoothed line through the total production data is a 5-point averaging line to indicate trend in total production.

The smoothed line in Figure 2.12 indicates total production between 1.0 and 1.5 million sockeye per year between 1950 and the mid-1970s, but declining production after that time. Total production crashed following the 1993 return and has become a major conservation concern, leading to a draft recovery plan (Holtby 2000). The cause of this decline is likely poor marine survival of smolts produced from the 1994 and 1995 spawning years (Rutherford and Wood 2000).

These authors present the limited data available for freshwater survival of sockeye fry in Owikeno Lake and note that, for both 1994 and 1995 spawning years, freshwater survival was above the long-term average. The estimation of marine survival of Owikeno sockeye smolts is limited by uncertainty about the juveniles in the lake during the fall (pre-smolts stage) and lack of actual information on smolt abundance. In the absence of a direct estimate of smolt survival, the rate of adult returns per spawner (in the parental generation) provides an index of survival. The index does not allow partitioning the source of mortality between freshwater and marine sources, but if Rutherford and Wood (2000) are correct in their assessment, then recent changes in returns per spawning adult would be attributed to conditions in the marine environment (Figure 2.13), or related to the uncertainty of spawning escapement surveys in this lake system.

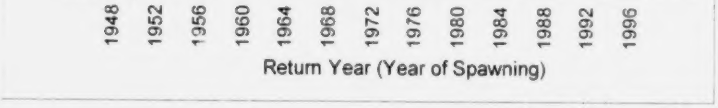


Figure 2.13. Return of adult sockeye salmon per spawner in the parent generation for Owikeno sockeye salmon. (1948-1998 spawning years).

Dots are the actual data per year, and the smoothed line is a 5-point moving average of trend over time.

A critical value to note in Figure 2.13 is 1.0 Returns per Spawner (R/S) on the vertical axis. Values below 1.0 indicate less than one adult returning per parental spawner and means that the population must decline in abundance. Values less than 0.1 R/S indicate that only one adult returned for every 10 spawners in the parental generation and means that the population would decline very rapidly. The series of R/S less than 1.0 since 1988 and 1989 will result in a continuous decline in the sockeye abundance as noted in Figure 2.12. Serious loss of sockeye production would result from the poor R/S noted for the 1994 and 1995 spawning years (lowest two points in Figure 2.13). Indeed, the poorest known return to Owikeno sockeye occurred in 1999 when a total return of only 4,300 sockeye (catch and escapement) was reported. On a positive note, however, total return of sockeye to the Owikeno Lake in 2002 was estimated to be 100,000. If marine productivity has improved, full recovery of this stock may still take several years because the reproductive capacity of brood years 1999 to 2001 was limited by the very low numbers of sockeye spawning.

Poor marine survival during the 1990s accounts for the poor total returns recently observed, but what accounts for the continuous gradual decline in total stock size and R/S observed in Figures 2.12 and 2.13? These could be associated with large-scale environmental changes in the landscape or could be an artifact of the data being collected. Uncertainty in the accuracy of spawning escapement records continues to be a significant limitation to the assessment of this stock. For example, if spawning escapements are underestimated, and fisheries have been significantly reduced recently, then the trend could simply reflect poorer and poorer accounting of the spawners in these tributaries, since these constitute the total return. This trend merits increased investigation.

2.4 Long Lake Sockeye

Almost all sockeye salmon production in Area 10 Smith Inlet originates from spawning areas in Long Lake. The lake is clear, cold and typically oligotrophic (Hyatt and Stockner 1985) with a surface area of 21 km^2 and two major spawning tributaries (Canoe and Smokehouse creeks). Long Lake drains into Wyclees Lagoon through the short Docee River (2 km).

Long Lake has been treated with nutrients via the Lake Fertilization Program since 1977 (Hyatt and Stockner 1985). The lake was initially treated in 1977 and 1979, but not during 1980 or 1981. The program resumed for 1982 through 1997. The history of lake fertilization as an enhancement program is described by Stockner (1987); fertilization is intended to compensate for nutrient limitation that occurs naturally in the lake and allows for increased food production intended for juvenile sockeye salmon. Fertilization usually occurs between April and September, so the first treated spawning year in Long Lake would have been 1976. **A very important feature of Long Lake is the Docee counting fence that has been operated by Fisheries and Oceans Canada since 1972.**

Spawning escapements to Long Lake have been recorded each year since 1951. Prior to 1963 sockeye escapements were estimated from visual surveys in the two tributaries. In 1963, an experimental program counted sockeye from a tower at the entrance to the lake. After a lapse of four years, the tower was operated again for 1968 to 1971, and then the permanent counting fence became operational for the 1972 return year. This provided an unusually good series of data of sockeye escaping into Long Lake, but does not necessarily represent the true spawning population if pre-spawning mortality occurs (although pre-spawning mortality is seldom accounted for). Total returns of Long Lake sockeye were estimated from the total commercial catch in Area 10 plus the annual spawning escapement (Figure 2.14).

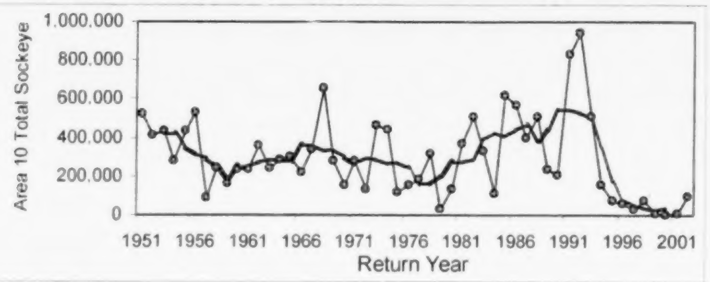


Figure 2.14. Annual total return (commercial catch plus spawning escapement) of Long Lake sockeye salmon to Area 10.

The smoothed line through the total production data is a 5-point moving average to indicate the trend in total production.

The smoothed line in Figure 2.14 indicates total production was typically between 200,000 and 400,000 sockeye per year between 1951 and the mid-1980s. Unlike the declining production trend for Owikeno sockeye, however, total returns in 1991 and 1992 were record high levels of production. This production peak was followed by a sharp decrease to the lowest levels ever observed (1999 to 2001). As with the Owikeno sockeye, Long Lake sockeye stocks have also become a major conservation concern, leading to a draft recovery plan (Holtby 2000).

Again similar to Owikeno sockeye, Rutherford and Wood (2000) suggest the low production resulted from poor marine survival rates for the 1994 to 1996 spawning years. Marine survival of sockeye juveniles emigrating from Long Lake can actually be estimated based on enumeration of pre-smolt sockeye resident in Long Lake. The hydroacoustic technique and annual surveys are conducted by the Stock Assessment Program (DFO, Science Branch) and have been documented by Hyatt et al. (2000). However, the pattern of survival based on juvenile enumeration and adult returns is identical in shape to the plot of recruits per spawner (R/S, the index used for Owikeno sockeye). For ease of comparison, the R/S data for Long Lake sockeye is presented. Estimation of total production from a spawning year requires knowing the age structure of the returning adults each year. Unfortunately, these samples were not collected in 1979 or 1983, with the resulting absence of data for four brood years. Adult returns per parental spawner since 1972, when actual counts of spawning escapements began, are presented in Figure 2.15.

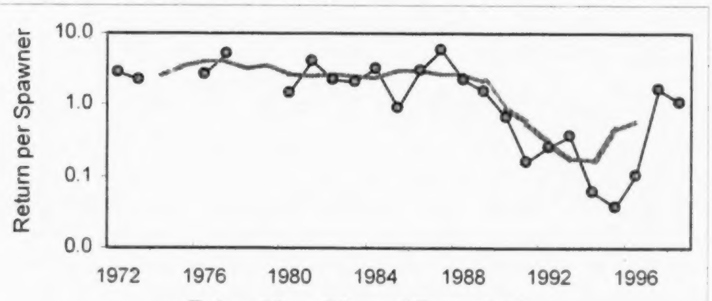


Figure 2.15. Return of adult sockeye per spawner in the parent generation for Long Lake sockeye salmon.

The dots are the actual data point per spawning year, and the smoothed line is a 5-point moving average to indicate trend.

As described above for Owikeno sockeye data, returns below 1.0 indicate less than one adult returning per parental spawner, resulting in a decline in abundance. Values of less than 0.1 R/S indicate that only one adult returned for every 10 spawners in the parental generation, obviously illustrating a very rapid population decline. The series of R/S less than 1.0 since 1990 resulted in a continuous decline in the sockeye abundance as noted in Figure 2.14. The lowest recorded returns of Long Lake sockeye have occurred since 1995. The count of sockeye passing the Docee fence in 2000 was actually only 1,430 adults. Subsequently, the return of sockeye to Long Lake in 2002 was estimated to be 92,000. As with Owikeno sockeye, even if marine productivity improves, full recovery of this stock will likely take several years.

2.5 Sockeye Salmon Summary

Sockeye salmon in central and northern BC are commonly associated with four large lake systems (Long Lake, Smith Inlet; Owikeno Lake, Rivers Inlet; Babine Lake, Skeena River; and Meziadin Lake, Nass River; Map 2). These lakes account for the vast majority of sockeye salmon production in this region, but they are only a small component of the diversity of spawning populations, both along the coast and in the larger rivers.

The Skeena River is clearly the largest sockeye producing river in the north. About 70% of the sockeye rearing area in the Skeena drainage, and over 90% of recent sockeye production from the Skeena River, is attributed to the Babine/Nilkitkwa Lakes, and the Babine Lake Development Program (BLDP) in Fulton and Pinkut rivers (major artificial spawning channels) of Babine Lake. Production from the Skeena has approximately doubled since completion of the BLDP in the early 1970s (Figure 2.2) but has also generated concerns about the harvesting impact on stocks returning to 27 other sockeye-producing lakes in the Skeena River. Returns to these lakes, collected within 13 river systems, are summarized in Table 2.1 of this report. When considered at the river system level, the response of the non-Babine sockeye populations to the BLDP has been mixed and the patterns of spawning escapements are quite different between systems.

Table 2.1 of this review indicates the status of the non-Babine Skeena River sockeye systems:

- three increased relative to the average escapement recorded for the 1950-1970 period (i.e., pre-BLDP);
- one was stable;
- three decreased;
- one is depressed, but the assessment is highly uncertain due to an absence of recent data;
- two could not be assessed due to an absence of base period data; and,
- three could not be assessed simply due to a general lack of data at any time.

Most of the non-Babine sockeye systems show a decline in escapements following completion of the BLDP and a subsequent recovery, but the timing of these declines is not synchronous, nor is the extent of decline equal. The pattern to Morrison Lake more clearly exemplifies the expected pattern of declining escapements as the sockeye returns to the BLDP increased, but even Morrison Lake sockeye show the increase in escapements in recent years.

These aggregate responses within river systems may also hide an impact on less productive spawning components of a system. However, to identify these will be difficult with the reduction in numbers of spawning tributaries that are assessed on an annual basis. The most immediate concerns for these non-Babine systems are for returns to the Bulkley and Maxan lakes, to the Lakelse Lake (but the changes in escapement surveys confound this assessment), and to Alastair Lake. Records of spawning escapements cannot be used to assess the current status of sockeye salmon returning to: Kitseguecla River, Kitwanga River, Kluatantan and Kuayaz Lakes, Sicintine River and Motase Lake, and Slamgeesh River.

Sockeye salmon in the central and north coastal islands, Portland Inlet and the Nass River, and on the Queen Charlotte Islands involve 65 lakes with adequate data for assessing escapement trends and another 52 with inadequate data. These counts do not include sockeye salmon returning to many tributaries of Owikeno Lake (Rivers Inlet) or Long Lake (Smith Inlet) in central BC. Sockeye returns to Meziadin Lake and its spawning tributaries represent the majority (77%) of the sockeye salmon returning to the Nass River basin (Figure 2.8). Table 2.2 of this report summarizes our assessment of this diverse collection of sockeye lakes. Of the 65 lakes that could be assessed five had increasing escapement trends relative to their base years, 22 were stable (±25% of base), 16 were decreasing, and 22 were depressed (less than 25% of their base abundance). **Since comparisons of escapement over time did not account for changes in fishing effort and catch, the degrees of change noted above are likely a conservative assessment of the actual decline in sockeye production over this time period.**

Smaller, coastal sockeye populations in central and northern BC likely constitute a significant component of the diversity in sockeye salmon, but of the 65 lakes with adequate data for assessment, 38 of these lakes (58%) were assessed to have significantly reduced current escapements relative to their previous levels.

Sockeye production from Owikeno Lake and Long Lake had been important to First Nations and commercial fisheries for many years, but since the mid-1990s have become a serious conservation concern. **Poor marine survival of juveniles from the 1994 to 1996 spawning years has resulted in record low returns of adults to both lakes (3,600 spawers recorded for Owikeno Lake in 1999, and 1,400 spawners for Long Lake in 2000).** Marine survival for the more recent spawning years has improved and returns to both lakes are beginning to recover. The returns to both lakes, however, remain below the desired spawning escapements for these lakes.

2.6 Council Discussion

There is a remarkable diversity of sockeye populations and an array of conditions influencing their status in the central and northern BC region. This review alone identifies 145 sockeye lakes, and this is surely a conservative accounting of sockeye populations since each lake system with a recorded sockeye spawning site is equated to one sockeye population. If the numerous spawning tributaries associated with some lakes were used to define the population units, then the total number would easily exceed 200 populations. **The appropriate level of geographic and genetic definition for the sockeye populations in this region is one of the major research and management challenges that remains to be addressed.** This issue is of particular concern for sustaining sockeye production in the future and is directly analogous to the recent article concerning 'Biocomplexity and Fishery Sustainability' in Bristol Bay sockeye salmon (Hilborn et al. 2003).

> *"This biocomplexity has enabled the aggregate of populations to sustain its productivity despite major changes in climatic conditions affecting the freshwater and marine environments during the last century." (abstract, Hilborn et al. 2003)*

Production in many of the larger lake systems of northern BC has been sustained or increased, but in central BC these larger systems (Owikeno and Long lakes) currently involve serious conservation and stock rebuilding issues. The assessments of sockeye stocks in many of the other lakes throughout this region are compromised by infrequent escapement surveys and uncertain accuracy of the data. But, for approximately one-third of the smaller lake systems in the coastal zone plus one non-Babine system within the Skeena River, the data that are available support concerns that escapements are depressed (defined as less than 25% of the sockeye escapement in a base period of years). It is interesting to note, however, that there are also many sockeye lakes where escapements have remained relatively stable or have increased relative to their base years. Given the diversity of environments involved and the unknown accuracy and consistency of escapement surveys over time, very little can actually be stated definitively concerning these small but diverse sockeye populations. **At the very least, a more consistent assessment survey**

procedure is required to monitor these sockeye populations and to ensure consistency of data quality over time. A substantial number of other sockeye lakes could not be assessed since the necessary data is no longer collected.

The Council is already aware that new assessment procedures for sockeye salmon are being investigated for these central and northern BC systems. Experience gained through the Lake Fertilization Program and Fraser Lake assessment programs suggest that assessing juvenile utilization and production capacity of the sockeye rearing lakes may be a more practical means to assess sockeye production and future potentials. The report by Shortreed et al. (2001) is a step towards these methods, and the paper prepared by Cox-Rogers et al. (May 2003 PSARC meeting) presented these methods for assessing the non-Babine sockeye production in the Skeena River.

The Council also notes the actions taken by Fisheries and Oceans Canada and harvesters to minimize the catch of Owikeno and Long Lake sockeye salmon during the current period of severely depressed production. **The efforts of Fisheries and Oceans Canada to work with local organizations and First Nations to develop conservation and rebuilding plans are strongly supported.** The Council is concerned, however, that the limitations of assessment programs for many of the smaller sockeye lakes in this region may lead to poorly-informed decisions concerning the status and conservation need of these small "populations". **Fisheries and Oceans Canada would be very well advised to conduct a concerted assessment of these lake populations and to study the genetic structure of these stocks more extensively in order to properly define the conservation units for sockeye in this region.** An improved flow of information and assessments will be essential to help resolve future discussions about measures to conserve the diversity of these sockeye spawning populations. The consideration of stock definitions in terms of biodiversity will be crucial for management purposes when the Wild Salmon Policy is finally implemented. A significant step forward in this has very recently been published by Nelson et al. (2003).

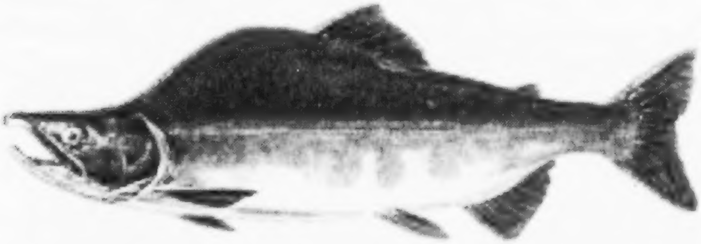
Sockeye salmon in central and northern BC are a vital resource to the local Native and non-Native peoples, their heritage and economies, and the ecosystems. At present, most of the useful assessment capabilities are directed towards the larger and commercially important sockeye populations in this region. While the need to broaden this assessment perspective is becoming acknowledged, the procedures to conduct accurate assessments of sockeye production and their potential remain to be established. **The Council strongly recommends the development of such an assessment protocol and funding of these efforts.** The Council will be particularly interested in the proposed assessment procedure being developed for non-Babine sockeye salmon in the Skeena River.

Whatever assessment protocols are implemented, the historical data and the "value" of each spawning population will certainly enter into future discussions, particularly given the 2003 proclamation of the Canadian Species at Risk legislation. An open and inclusive process of management and recovery planning will be essential as new information becomes available and new assessments are conducted.

3.0 PINK SALMON (*ONCORHNYCHUS GORBUSCHA*)

The central and northern region continues to support a diversity of pink salmon populations, both in numerous small coastal rivers and a few larger rivers.

Mature male pink salmon



The majority of pink salmon production occurs in only a few large populations, but their wide distribution also makes them an important ecological keystone species in the coastal watersheds (see Gresh et al. 2000, Cederholm et al. 1999, 2000; Willson and Halupka 1995, and Chapter 2 in Harvey and MacDuffee 2002). Abundant returns of pink salmon provide tonnes of marine nutrients to these freshwater ecosystems.

3.1 Central British Columbia

Pink salmon in central coast BC (statistical areas 7 to 11) have been reported in 125 streams. Spawning records for pink salmon have been maintained since the early 1950s, but the streams monitored have varied over time, methods of enumeration have changed, and the effects of fisheries and habitat alterations have undoubtedly affected streams to varying degrees. The vast majority of spawning escapement data for pink salmon is based on visual observations by fishery guardians who conduct walks of streams and/or over-flights at peak spawning times. These data are not likely to be highly accurate on a stream-by-stream basis, but efforts are made to conduct annual surveys in a consistent manner so that the trends over time are representative of changes over time and areas. Escapements of pink salmon in central BC have been quite stable on a decadal average in both even and odd years (Table 3.1), but are much more variable on an annual basis. Since pink salmon have a fixed age-at-maturity of two years, there is no exchange of adults between these year-lines. It is quite common that the production in even and odd-year lines differ. Consequently, population statistics for pink salmon usually report returns for each line separately.

Table 3.1. Decadal average spawning escapement values for central coastal BC pink salmon (millions of fish) by even and odd-year lines, and the average number of streams surveyed during each decade.

The proportion of the total escapement attributed to pink salmon in the Bella Coola/Atnarko rivers is presented to indicate the major contribution from this one large system.

Period	Even-Year Pinks (ave. # streams)	Odd-Year Pinks (ave. # streams)	Bella Coola/Atnarko rivers % of Even Yr.	% of Odd Yr.
1951-1960	1.0 million (81)	0.9 million (81)	50%	38%
1961-1970	2.2 million (90)	0.7 million (81)	64%	50%
1971-1980	2.0 million (102)	0.8 million (102)	65%	29%
1981-1990	3.0 million (111)	1.6 million (118)	47%	56%
1991-2000	2.4 million (99)	1.6 million (94)	54%	75%
2001 or 2002	3.3 million (66)	4.0 million (53)	45%	48%

Spawning returns of pink salmon to the Atnarko River have been enumerated by more quantitative methods than is usual in the Central Coast. Since 1971, visual counts of pink salmon have been conducted from a tower as the fish pass over a white background set across the river bottom. The counting tower is located on the Atnarko River, approximately 1km upstream from the confluence of the Talchacko and Atnarko rivers (Bella Coola River system). Virtually all of the pink salmon and coho salmon migrating upstream to spawn in the Atnarko River must swim past it. The accuracy of the count was verified by externally marking a large number of pink salmon and then releasing them again about 500m downstream from the tower. The marked fish are then counted as they migrate upstream and over the counting boards. Over 95% of the tags were accounted for when counting from dawn to dusk count (Hilland to West, 1982, DFO Internal memo).

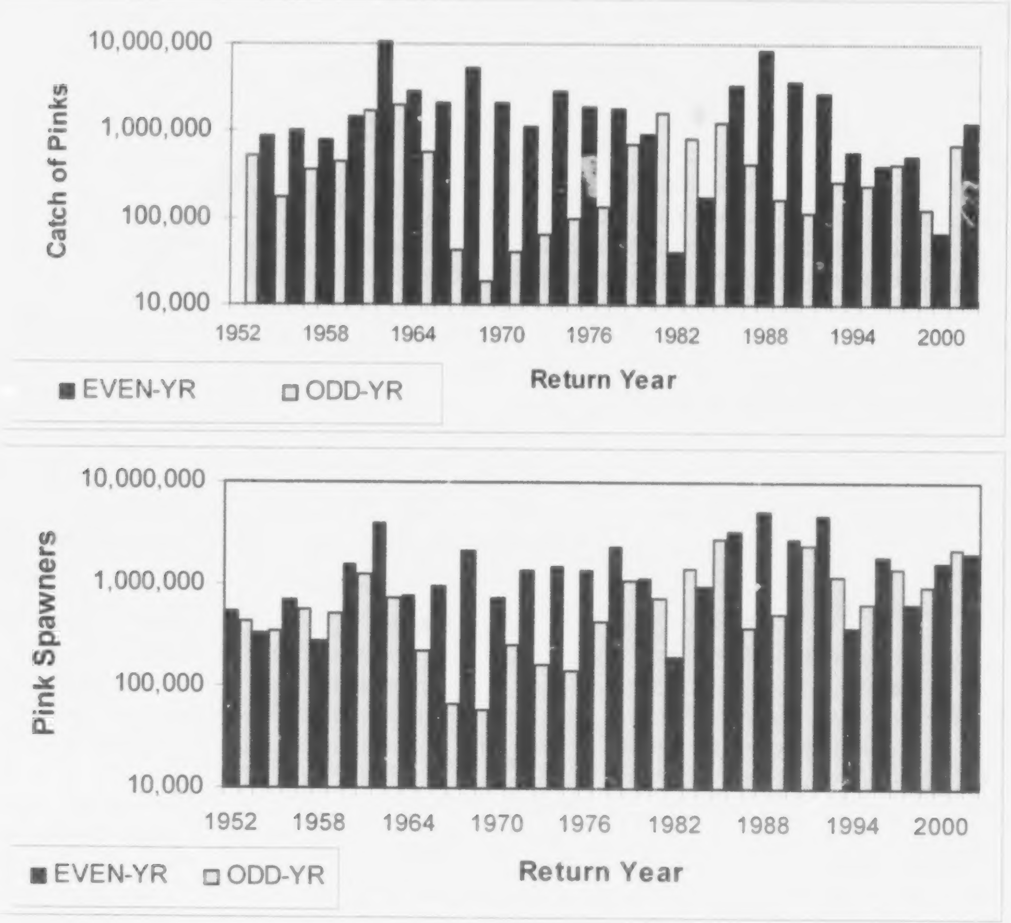
More recently, due to budget cut-backs in the 1980's, the duration of the count was reduced to 10, 8 and finally 6 hours. Daily migration is now estimated by extrapolating the 6 hour count using statistical methods (Area-Under-the-Curve, AUC) estimates, Cox-Rodgers to Peacock, 1995, internal DFO memo). Several times a year the AUC extrapolation is checked against an actual dawn to dusk count, to ensure accuracy and consistency (Willson, 2000). Since 2001, the tower count has been managed by the Nuxalk first Nation, under the supervision of a DFO Fisheries Management Technician.

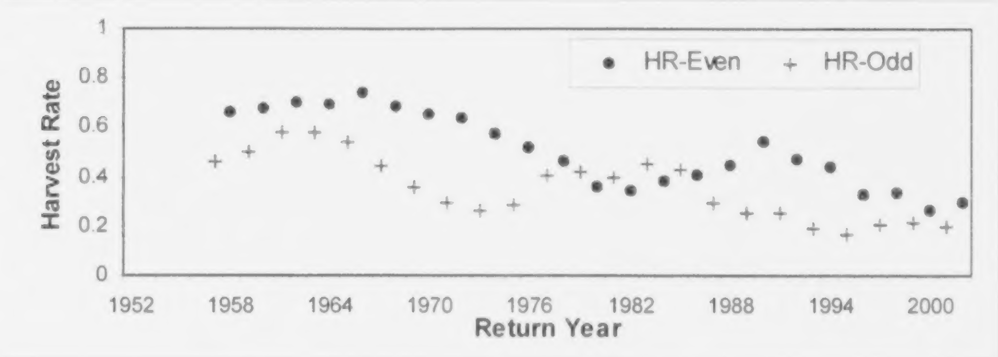
Pink salmon in numerous other Area 8 streams are enumerated by over-flights and patrolmen counts. Pink salmon tend to hold on the spawning grounds for an extended time and usually allow for reasonable counts. The major systems, such as the Dean, Kwatna and Koeye rivers, are monitored by over-flights, but the smaller streams with complete forest canopy are monitored by patrolmen on walking surveys. The lower Bella Coola River is also walked on a weekly basis due to the turbidity of that system. Some of the smaller streams are not visited as frequently, but usually get a spot check (ideally near peak-spawning time). Recently, the Heiltsuk and Kitasoo Bands have also been providing stream counts to supplement Departmental coverage.

Based on these counts of pink salmon, the catch and spawning escapement to Area 8 (Bella Coola region) has been used as an indicator of pink salmon status in the Central Coast. Catches cannot be identified to individual spawning populations since the fisheries occur in the marine channels and outer coast, but by summing spawning escapements in Area 8 streams (that are dominated by the Atnarko counts) a time trend in total production can be established and harvest rate by the fishery estimated. In this example, harvest rate is estimated as the total of reported catches divided by the sum of these catches plus the total Area 8 spawning escapements. It should be noted, though, that the harvest rate is likely over-estimated since visual counts of spawning escapements almost assuredly under-estimate the total number of spawners. Also, in early years when a significant portion of the catch was taken in outer coastal areas, some of the pinks caught would not have been returning to Area 8. The number of these non-Area 8 pinks is unknown, but likely contributed to the larger harvest rates estimated in the first half of this time series. Figure 3.1 presents the time series of commercial catches of pink salmon in Area 8, spawning escapements, and the harvest rates by even and odd-year lines. The harvest rates presented are 5-point averages (5 points per decade in each line) to emphasize the trend in harvest rates but not the annual variability in the harvest.

Figure 3.1. Area 8 (Bella Coola region) Pink salmon commercial catches, spawning escapements, and the trend in commercial harvest rates (5-point averages per line).

Even and Odd-year line pink salmon are identified separately in each figure.





Total production in the even-year Area 8 pink salmon has been more consistent than in the odd-years, but in recent years their production levels have been similar and increasing. Harvest rates have been lower on the odd-year line (only about 20%), compared to 20-40% on the even-years, but both are much lower than in the earlier years.

In terms of monitoring pink salmon in the other streams, Fisheries and Oceans Canada has apparently invested a significant effort in maintaining these surveys, in both the even and odd-year lines. To examine the distribution of escapement surveys, all escapement data for the pink salmon were separated into even and odd-year lines, and then the frequency of monitoring examine by stream within year-line. Both even and odd-year pink salmon spawn in most streams, but there are some with only one of the lines. As noted above, pink salmon spawning has been recorded in 125 different streams in the region and between 81 and 118 of these streams have been monitored each decade. If a large number of streams were rarely visited (for example, only once in the 5 spawning years per decade) then these large number of streams may still not provide very informative data on pink salmon status. However, this has not been the case. **Between the 1950s and 1990s, over three-quarters (75%) of the streams in central BC have been surveyed three or more times in every five years. This is a particularly good record of survey effort given the remoteness of most rivers and the area covered.** To demonstrate the frequency of surveys over time, Figures 3.2 and 3.3 present the frequency of the streams surveyed per decade (see Table 3.1 for the number of streams involved) for the Even-year and Odd-year lines, respectively.

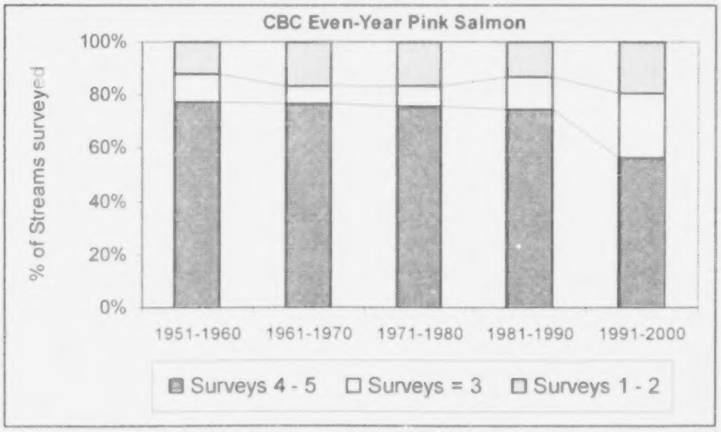


Figure 3.2. Percentage of the streams in the Even-year line of pink salmon that have been surveyed 4 or 5 times (i.e., 80 to 100%), 3 times (60%), or 1-2 times (40% or less) in each decade.

Note that the specific streams surveyed do vary over time.

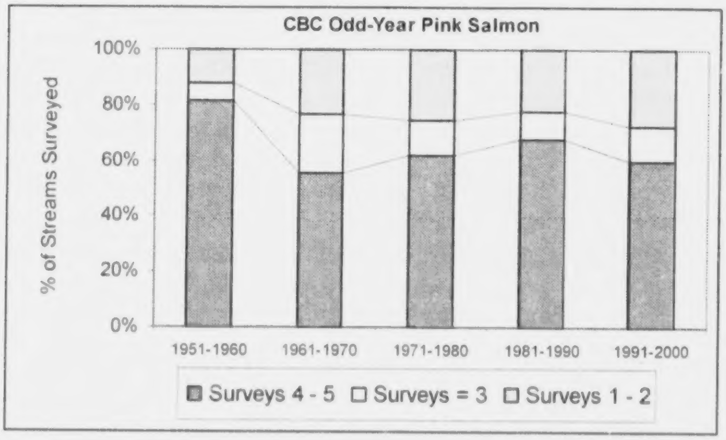


Figure 3.3. Percentage of the streams in the Odd-year line of CBC pink salmon that have been surveyed 4 or 5 times (i.e., 80 to 100%), 3 times (60%), or 1-2 times (40% or less) in each decade. *Note that the specific streams surveyed do vary over time.*

The frequency of escapement surveys decreased slightly in the 1991-2000 period, but has decreased much more during 2001 and 2002. During 2001, only 53 streams have recorded escapements or visitations, and in 2002 only 66 streams are noted. However, in 125 possible streams with pink salmon, even these numbers of streams could provide a reasonable indication of pink distribution and abundance trend depending on how the streams were selected, past survey frequency, and distribution in central BC.

To examine changes in the diversity of spawning streams, the PFRCC (2002) previously used figures comparing the number of streams contributing to the cumulative number of spawners in each decade. Curves that rise rapidly and then quickly flatten indicate that a few streams contribute the vast majority of the total spawning population. Curves that rise more slowly and continue to rise over many streams indicate that many more streams contribute to the total spawning population. **Curves for central BC pink salmon over the five decades since the 1950s tend to rise rapidly with 85% or more of the total spawning population accounted for by the 15 largest spawning streams in both the Even and Odd-year lines.** The curves for each decade are very similar in shape and overlap extensively when plotted. Consequently, these plots are not very informative about changes in stream diversity. The only separation between the curves is due to changes in pink salmon abundances over time. However, if the streams included in the first 15 streams are compared over time, it is apparent that changes have occurred. The most direct means to demonstrate these changes is simply to list the 15 largest pink salmon spawning populations in the region by year-line and decades (Table 3.2). In this table, the largest 15 populations during the 1951-1960 decade are compared to the most recent decade (1991 to 2001 or 1992 to 2002).

Table 3.2. Listings of the 15 largest pink salmon spawning populations in central BC by Even and Odd-year Lines.

Within each line, the streams ranked from largest to 15th during 1951-1960 are compared against the most recent decade, and the statistical area of the stream is included in brackets.

Odd-Year Line 1951-1960	Odd-Year Line 1991-2001	Even-Year Line 1951-1960	Even-Year Line 1992-2002
1. Bella Coola & Atnarko Rivers (8)	1. Bella Coola, & Atnarko Rivers	1. Bella Coola & Atnarko Rivers (8)	1. Bella Coola & Atnarko Rivers
2. Koeye River (8)	4. Koeye River	2. Koeye River (8)	6. Koeye River
3. Kainet River (7)	5. Kainet River	3. Kainet River (7)	7. Kainet River
4. Kwatna River (8)	7. Kwatna River	4. Clatse River (7)	15. Clatse River
5. Neekas River (7)	14. Neekas River	5. Neekas River (7)	8. Neekas River
6. Mussel River (7)	6. Mussel River	6. Mussel River (7)	11. Mussel River
7. Clatse River (7)	9. Clatse River	7. Jenny Bay Creeks (8)	27. modest decline to several thousand spawners
8. Dean River (8)	11. Dean River	8. Kwatna River (8)	4. Kwatna River
9. Nameless Cks (7)	Declined to a few hundred spawners	9. Salmon Bay Ck (7)	24. modest decline to several thousand spawers
10. Kilbella R (8)	3. Kilbella R.	10. Nekite River (10)	13. Nekite River
11. Chuckwalla R (8)	2. Chuckwalla R.	11. Johnstone Ck (9)	9. Johnstone Ck
12. Nekite River (10)	15. Nekite River	12. Nootum River (8)	Significant decline to few hundred spawners
13. Salmon Bay Ck (7)	Declined to a few hundred spawners	13. Hook Nose Ck (8)	36. declined to a few thousand spawners
14. Johnstone Ck (9)	13. Johnstone Cr	14. Carter River (7)	17. Carter River, no decline in average number of spawners
15. Carter R (7)	10. Carter River	15. Cooper Inlet Creeks (7)	21. Cooper Inlet, no decline in average number of spawners
Kimsquit River ... much smaller numbers in Odd-year line.	8. James Bay Ck (7)		2. Kimsquit River (8)
	12. Korich Ck (7)		3. Chuckwalla R (8)
			4. Kilbella R (8)

In both the Even and Odd-year lines, two or three of the larger populations during the 1950s have declined in size, but others have increased substantially. The inclusion of these new large populations has resulted in some populations dropping out of the top group of streams, but their average escapement sizes have actually not declined (e.g., Carter River and Cooper Inlet Creeks, Even-year line). Why these populations changed so much would require a more specific investigation of each watershed, the run timing and fishery impacts in various populations, and the localized pressures on them. The Raincoast Conservation Society report (Harvey and MacDuffee 2002) began to look more specifically at watershed and enhancement[7] records, but only related whether or not logging and enhancement was occurring in their "indicator" watersheds by statistical areas (Appendix 3 of their report). An expansion of this type of analysis would be required if explanations were required.

In general though, it is apparent that most of the rivers that support the largest pink salmon populations have been the same over time, with the exception of the Chuckwalla, Kilbella, and Kimsquit rivers that have substantially increased in population sizes. **The centre of pink salmon abundance is the mainland rivers of statistical areas 7 and 8, but areas 9 to 11 have much lower pink salmon production (see Map 1).** Any further investigation of changes in population diversity or habitat impacts on pink salmon will have to consider the large number of medium to small stream populations throughout the coastal islands and mainland.

3.2 Northern British Columbia

Describing the pink salmon resource of northern BC is much more difficult than for central BC simply because of the number of streams involved and the diversity of areas included. As for sockeye salmon, northern BC will be presented by sub-areas (Queen Charlotte Islands, Nass River, Skeena River, Kitimat Inlet, and the coastal north coast). An historical summary of the average number of pink salmon spawners by sub-areas and decade, and the number of streams surveyed, is presented in Table 3.3. Overall and since 1950, the number of streams with pink salmon spawning recorded has varied from 235 in 1950 up to 448. In total, the number of unique streams with pink salmon spawning recorded varied from about 370 streams in the Odd-year line to 450 in the Even-year line.

The numerous pink salmon streams in the northern region make a brief summary of Table 3.3 difficult. But comparing the summary in Table 3.3 with the detailed escapement records and with the results for the central coast, there are a few notable points:

1. The number of streams in the north is substantially greater than in the central region but the total number of pink spawners is not, on average, proportionately greater. Pink returns in central region are concentrated in the Bella Coola and Atnarko rivers, but there is no equivalent dominant system in the north. There are a few larger rivers with larger populations, but pink production in the north comes from many moderate sized rivers.
2. As in the Central Coast, northern pink salmon escapements in Even-year line have been greater than in the Odd-year line, but the lines are more similar in size in the past decade. The number of streams involved was typically greater in the Even-year line.
3. The Nass River and the Queen Charlotte Islands are not typically large producers of pink salmon. They have much lower levels of pink salmon returns than the other sub-areas. Even-year returns to the Yakoun River, Queen Charlotte Islands, are the significant exception.
4. Also like central BC, the number of northern streams with pink salmon reported during 2001 and 2002 are much lower than in previous years. The reported total escapement, however, were comparable with the past decade and suggest a substantial increase in pink salmon production.

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[7] One pink spawning channel was constructed by the Salmonid Enhancement Program, DFO on the Atrnarko River.

Table 3.3. Average size of pink salmon spawning escapements by decade (5 years per line) presented by Even and Odd-Year Lines, Sub-Areas of NBC, and the number of streams included in each average (i.e., the number of streams with recorded escapements).

Areas	Pink Lines	1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001	2002
Kitimat	Even-Yr Line	204,000	467,000	1,564,000	835,000	988,000	923,000		688,000
	Odd-Yr Line		254,000	621,000	317,000	639,000	514,000	1,611,000	
NassR	Even-Yr Line	9,000	12,000	18,000	14,000	34,000	5,000		None recorded
	Odd-Yr Line		15,000	31,000	23,000	102,000	18,000	15,000	
Ncst	Even-Yr Line	495,000	382,000	617,000	600,000	654,000	511,000		1,168,000
	Odd-Yr Line		226,000	342,000	260,000	726,000	745,000	1,382,000	
QCI	Even-Yr Line	918,000	1,153,000	1,532,000	1,005,000	1,549,000	1,870,000		1,626,000
	Odd-Yr Line		86,000	124,000	33,000	26,000	16,000	7,000	
Skeena	Even-Yr Line	564,000	500,000	1,063,000	791,000	1,462,000	735,000		351,000
	Odd-Yr Line		833,000	967,000	1,136,000	2,691,000	1,899,000	843,000	
NBC	Even-Yr Line	2,191,000	2,513,000	4,794,000	3,246,000	4,687,000	4,044,000		3,832,000
TOTAL	Odd-Yr Line		1,414,000	2,084,000	1,770,000	4,184,000	3,192,000	3,858,000	

Areas	Pink Lines	1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001	2002
Kitimat	Even-Yr Line	93	102	102	107	110	98		75
	Odd-Yr Line		101	104	105	109	95	68	
NassR	Even-Yr Line	4	5	9	18	20	5		0
	Odd-Yr Line		6	10	19	20	8	2	
Ncst	Even-Yr Line	68	82	84	99	109	95		60
	Odd-Yr Line		81	87	90	104	101	80	
QCI	Even-Yr Line	43	95	113	123	137	131		87
	Odd-Yr Line		30	46	57	60	45	13	
Skeena	Even-Yr Line	27	32	51	54	72	50		6
	Odd-Yr Line		31	51	59	78	61	12	
NBC	Even-Yr Line	235	316	359	401	448	379		228
TOTAL	Odd-Yr Line	0	249	298	330	371	310	175	

It is also notable that pink salmon in the Queen Charlotte Islands are much more limited in the Odd-year line and their use of streams more diverse in the Even-year line. These observations have also been made for pinks along the west coast of Vancouver Island.

While there is no dominant pink population in the north, there are a number of rivers that have consistently produced large returns. These rivers have been identified based on their decadal average escapement being approximately 100,000 pink or more. In the Odd-year line and by sub-area, this list becomes quite small and includes:

Kitimat sub-area: Quaal River (followed by smaller returns to the Kitimat and Kemano)

Nass River sub-area: No tributaries in the Nass meet this definition, but the Ksi Hlginx (previously Ishkheenickh River, changed May 2000 with Nisga's Treaty) has the most consistent record of pink salmon with approximately 15,000 spawners on average.

North Coastal sub-area: The largest consistent producer is the Kwinamass River in Portland Inlet, followed by the Knukw (Iknouk River in the lower Nass River). Large returns have been recorded in the Khutzeymateen (Portland Inlet) and the Khyex (lower Skeena) rivers, but not as consistently as in the Kwinamass River.

Queen Charlotte Islands sub-area: Only the Copper and Tlell rivers have records of consistent pink salmon returns in the odd years. Neither of them would be considered a large pink salmon system, but spawning escapements to the Copper River have decreased to a few thousand from a previous range of 30,000 to 40,000.

Skeena River sub-area: The Skeena River (excluding the coastal area 4A) contains several large pink salmon systems, including the Babine River, Kispiox River, Kitwanga River, and Lakelse River. The latter is the largest Odd-year pink salmon system. At times, substantial pink escapements have also been recorded to the Morice River (upper Skeena) and in the lower Skeena River (referred to as West Skeena in escapement records).

In the Even-year line, pink salmon returns are more diversified and were historically much larger. By sub-area, the rivers included are:

Kitimat sub-area: Kitimat and Kemano would join the Quaal as major producers.

Nass River sub-area: None, the same comments as above would hold, but return numbers are even lower, approximately one-half in the Ksi Hlginx.

North Coastal sub-area: The Odd-year systems noted above would again be the largest pink spawning populations but the average escapement sizes are lower, and the returns to the Knukw (lower Nass River) become negligible in the Even-years. Two coastal systems in upper Grenville Channel become significant pink producers, Kumealon Creek and Moore Cove Creek.

Queen Charlotte Islands sub-area: Pink salmon spawning numbers are much greater in the Even-year line and a number of streams become notable producers. The Yakoun River is the major producer with average spawning estimates ranging from 100,000 to nearly 1 million pink salmon. However, a number of other systems typically have 50,000 to 100,000 spawners on average: Brown's Cabin Creek, Copper River, Deena River, Mathers Creek, Naden River, Pallant Creek, and Skedans Creek. It is interesting to note that none of these systems are along the outer west coast of the Queen Charlotte Islands.

Skeena River sub-area: The same systems identified above for the Odd-year line are also the major Skeena pink salmon systems in the Even-year line, but the size of the escapements is lower on average. The Lakelse and Yakoun rivers are similar in average Even-year returns.

The frequency of spawner surveys in northern pink salmon streams is a strength, as was noted in the central region. The accuracy of the number of spawners is likely low because the vast majority of the surveys are based on visual methods and streams could have been inspected once or several times within a year. However, with a high frequency of streams inspected each year, Fisheries and Oceans Canada is able to monitor the distribution of pink salmon, the trends in relative population sizes between streams within a year and within a stream between years. These visual surveys can also be an important check on the habitat conditions, water levels, etc. Since the north has been separated into five sub-areas, two figures are presented for each year-line:

- Figures 3.4 and 3.5 are the same presentation as for the central region pink salmon (i.e., frequency of surveys to all northern streams recorded with pink salmon in each decade).
- Figures 3.6 and 3.7 demonstrate the change in coverage over time and within sub-areas.

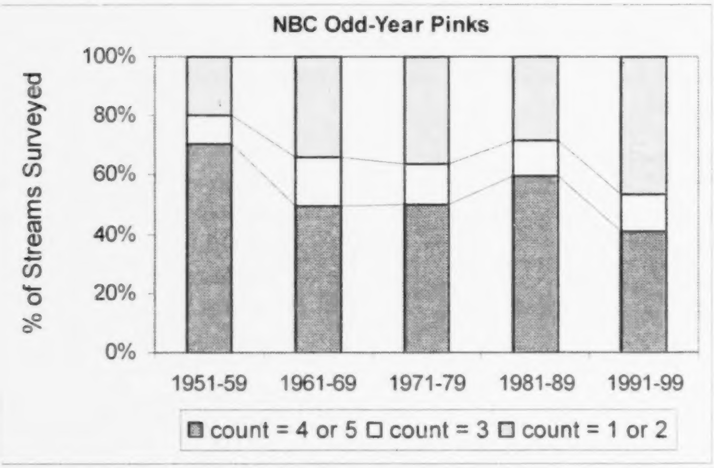


Figure 3.4. Percentage of the monitored streams in the Odd-year line of northern BC pink salmon that have been surveyed 4 or 5 times (i.e., 80 to 100%), 3 times (60%), or 1-2 times (40% or less) in each decade.

Note that the specific streams surveyed do vary over time.

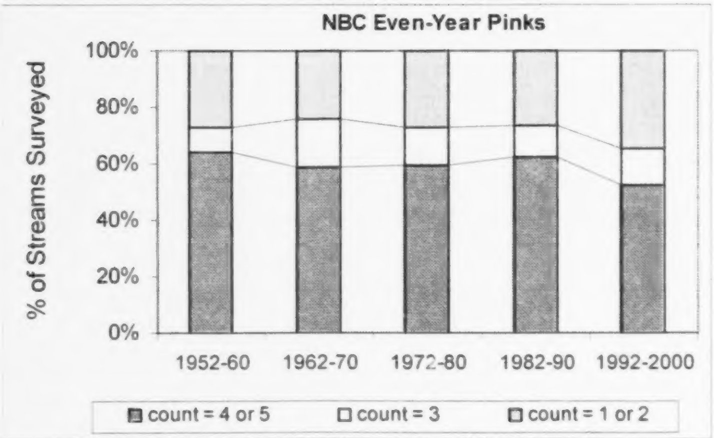


Figure 3.5. Percentage of the monitored streams in the Even-year line of northern BC pink salmon that have been surveyed 4 or 5 times (i.e., 80 to 100%), 3 times (60%), or 1-2 times (40% or less) in each decade.

Note that the specific streams surveyed do vary over time.

In the Even-year line, about 75% of the pink spawning streams have been surveyed at least 3 out of every 5 years between 1950 and 1990; this was reduced to 65% during the 1990s. The frequency of surveys was less and more variable in the Odd-year line, but there were still between 63% and 80% of the streams surveyed at least 3 out of every 5 years, and reduced to 53% in the 1990s. The primary reason for this difference between the year-lines is the large number of pink streams on the Queen Charlotte Islands with small numbers of pink salmon estimated to use those streams. As would seem reasonable, the inspections of those streams were less frequent. **Overall, though, there has been a significant effort invested in monitoring these northern BC pink salmon streams.**

The frequency of survey coverage does vary between the northern sub-areas and has generally declined during the 1990 to 2002 period. Some points are notable to keep in mind:

- There has been a low frequency of pink salmon stream surveys in the Queen Charlotte Islands sub-area during the Odd-year line (Fig. 3.6) over all five decades.
- There has not been a significant change in the sampling frequencies in the Kitimat or North Coastal sub-areas over this time period, nor in the 1990s.
- The Skeena sub-area maintained about a 60% sampling frequency over the first four decades, but has allowed a significant decrease to only 27% during the 1990s.
- The Nass River sub-area has sampled between 40 and 80% of the streams at least 3 out of 5 years over the first four decades but also allowed a significant decrease to only one in eight streams (12.5%) during the 1990s.

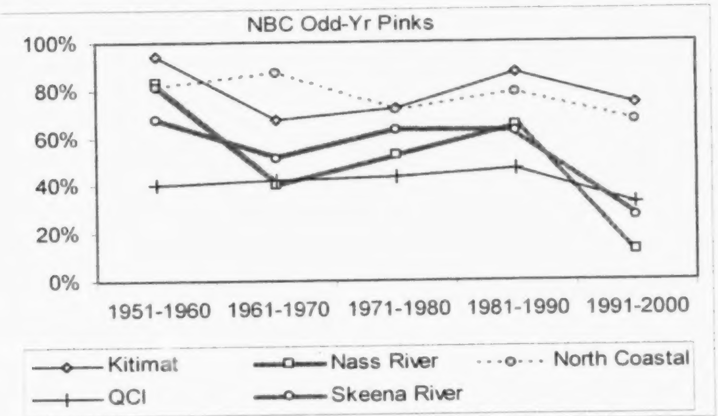


Figure 3.6. Changes in monitoring frequency by sub-areas and decades in the Odd-year line of northern BC pink salmon.

The plot is the percentage of all streams surveyed (i.e., any stream with an escapement record in a decade) 3 out of 5 years per decade in each sub-area.

It should be noted that the Nass River sub-area has monitoring for between 6 and 20 streams containing pink salmon, and many of these have very small populations. The establishment of the Nisga's Treaty in May 2000, and the programs during the 1990s leading up to this Treaty, may also account for the decline in sampling. New assessment programs have been implemented under the Treaty. In 2001, however, only two stream records of pink salmon spawners were reported from the Nass River.

Of greater concern than the Nass River sub-area is the decline in survey coverage in the Skeena River. Pink salmon production in the Skeena is significant, but the frequency of spawning surveys has decreased substantially since the early 1990s. By 2001, only 12 stream records of pink salmon spawners were reported from the Skeena River sub-area (see Table 3.1).

Stream survey coverage in the Queen Charlotte Islands is much greater in the Even-year line (Fig. 3.7) than in the Odd-year line. For QCI, the proportion of streams with at least 3 out of 5 years sampled increased to about 75% and has remained between 65% and 70% during the past two decades. In the Even-year lines of the other sub-areas there are differing rates:

- There has not been a significant change in the sampling frequencies in the Kitimat or north coastal sub-areas over this time period, nor in the 1990s.
- A steady decline has occurred in the percentage of streams surveyed at least 3 out of 5 years in the Nass River sub-area; but it should be recalled that there is a very small number of streams involved in the Nass River (see Table 3.1).
- There had been quite consistent sampling in the Skeena River sub-area (at least 50% of the streams surveyed) until the last decade when the coverage decreased by about half.

The most significant concern for changes in the monitoring of pink salmon spawning in the Even-year line is the major decrease within the Skeena River sub-area. **The Skeena has substantial pink salmon escapements in both the Odd and Even-year lines, but assessment coverage of the escapements has decreased substantially in both lines in the past decade.**

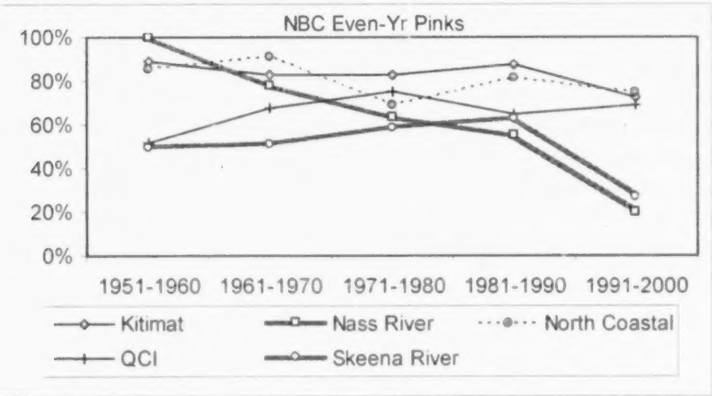


Figure 3.7. Changes in monitoring frequency by sub-areas and decades in the Even-year line of northern BC pink salmon.

The plot is the percentage of all streams surveyed (i.e., any stream with an escapement record in a decade) 3 out of 5 years per decade in each sub-area.

3.3 Pink Salmon Summary

Pink salmon are widely distributed throughout central and northern British Columbia in both large and small river systems. In total, pink salmon spawning has been recorded in about 520 different streams in the Odd-year line and over 600 streams in the Even-year line. Pink salmon production in the central region is dominated by production from the Atnarko/Bella Coola River system, although other large systems have increased in recent years (in particular the Kimsquit, Chuckwalla and Kilbella rivers). In the north, there are relatively few very large populations (most notable systems were the Lakelse River in the Skeena, and the Yakoun River during Even-years) but there are several more moderate sized rivers with large production. There are also exceptions where pink salmon are much more limited in abundance. These include statistical Areas 10 and 11 in south-central BC, the Nass River system up-stream of the lower river tributaries, and the Odd-year lines on the Queen Charlotte Islands.

In recent years there has been an increase in spawning escapements recorded in most of the pink salmon streams that were surveyed. These results are, however, confounded by a significant reduction in the number of streams surveyed (particularly during 2001 and 2002) and the lower frequency of surveys between years (i.e., during the 1990s). These reductions are in contrast with the substantial effort that Fisheries and Oceans Canada had directed towards maintaining stream surveys during the 1950 to 1990 period. The exact year of reductions will have undoubtedly varied between streams (the 1990 date is only used here as it defines the end of the 1980s decade). **Since there is very little quantitative data on pink salmon in central and northern BC, these historical spawning escapement surveys are the heart of our information on pink salmon. Changes in the relative size of spawning populations between streams, and within a stream but between years, are the best available indicators of pink salmon status. This is especially true now due to major reductions in fisheries and fishery related data.** The recent changes in escapement monitoring are of particular concern in the Skeena River where pink production can be substantial in both year lines.

3.4 Council Discussion

Pink salmon in central BC (Areas 7-11) and in northern BC (Areas 1-6) remain a diverse resource with evidence of increasing spawning population sizes recently. The PFRCC also noted the extensive effort to monitor this resource in the past, but our primary concern now is about the questionable ability of Fisheries and Oceans Canada to assess these resources reliably in the future. The historical information for assessments includes spawning escapement trends and reported catch, but the availability of sufficient information has been compromised by reductions in monitoring of spawning populations and reductions of fisheries over the past several years.

The diversity of pink salmon populations throughout the region makes it very clear that catch will be of mixed origin and difficult to associate to each population. Furthermore, variations in catch may be attributed to changes in survival rates of the pinks, productivity in freshwater, and/or changes in fishery impacts. Without any indicator populations with quantitative information on annual survival rates and fishery harvest rates, historical catch data is of limited value for assessment of specific pink salmon populations. The issue of adequate spawning escapement data is a concern given recent reductions in survey coverage and frequency of surveys in streams. Also, with very few exceptions, the accuracy of the surveys is unknown.

The quality of data needed for an assessment is related to the fishing intensity (or other impacts) that may impact the pink salmon populations. If harvest rates are expected to be high, then more quantitative data should be collected. But if the harvest rates are expected to be low to moderate (possibly in the 20% to 40% range) then more qualitative methods for escapement monitoring may be adequate, depending on the confidence that can be placed on the escapement surveys. In recent years, commercial fisheries on pink salmon have been limited by efforts to reduce by-catch in mixed-stock fisheries and by reduced salmon prices. These limitations could change, but future fishing opportunities could also be limited by the effort to return more pink salmon to freshwater and terrestrial ecosystems for nutrient purposes, especially in small coastal watersheds (e.g., see Harvey and MacDuffee 2002, or Cederholm et al. 2000), and for conservation and precautionary management. The latter follows naturally from the limited nature of the data for pink salmon assessment and management. The inclusion of ecosystem objectives and acknowledgement of the precautionary approach are likely to reduce the recommended harvest rates in fisheries and emphasize the diversity of spawning pink salmon over watersheds (rather than the production of pink salmon in a few major river systems).

Given the reasons outlined above and the absence of quantitative information on the vast majority of central and northern pink salmon populations, plus the recent declines in escapement survey coverage, the PFRCC recommends a cautious approach in establishing harvest levels on these stocks. **We note that with limited fishing pressures, less quantitative methods for escapement surveys may be adequate, but there must be attention to the design of surveys within years and streams, and over years to establish a degree of confidence in the results.** Visual surveys of pink spawners could provide an adequate basis for assessment of relative change, but this does not eliminate the need for a statistical basis of these surveys and a commitment to follow the procedures. The PFRCC recommends, therefore, the establishment of an explicit assessment framework for pink salmon populations in the central and northern regions. Efforts should be directed to ensuring consistency of methods over time, and quantifying the accuracy and precision of surveys adopted in the assessment framework.

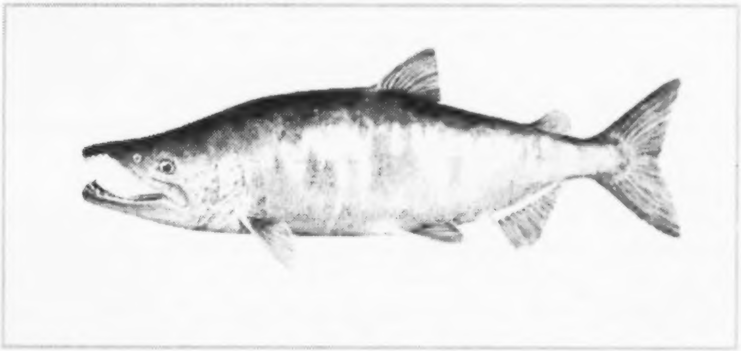
Furthermore, if fishing pressure begins to increase on these stocks, the question about what constitutes a modest harvest rate versus a high rate will ultimately require an answer. The only means to prepare for this question is to identify and monitor key indicator populations to allow the estimation of sustainable harvest rates and variation in survival, and to develop better forecasting tools. The development of these indicator streams for pink salmon could be expensive, and their value relative to the broader escapement surveys will have to be considered.

For pink salmon, another related question relevant to the Species At Risk Act and Wild Salmon Policy is what defines a conservation unit for pink salmon. The issue of homing and the uniqueness of specific stream populations remains uncertain for pink salmon. This issue must be addressed within year lines because there is no crossover between the Even-year and Odd-year lines. Within lines, however, the literature differs on how much straying occurs between local populations, and how much of the variation between populations is measured using genetic markers (for example, see Heard 1991 for a review). If fishing mortality remains low, then these questions are again less urgent as natural processes should dominate the production dynamics in each population. However, the question remains important if habitat impacts were, for example, to threaten salmon productivity within a watershed and/or affect the dynamics of pink salmon between populations.

4.0 CHUM SALMON (*ONCHORHYNCHUS KETA*)

The northern and central BC regions contain an array of chum salmon populations. The size of the chum salmon populations is generally much smaller than for pink salmon, and they do not seem to be thriving to the same extent in terms of current stock status.

Mature male chum salmon



Chum salmon in the northern and central BC regions may be classified as Summer chums or Fall chums depending on their adult migration timing back to their natal stream and spawning time. Summer chums are larger and older chum salmon, and are typically finished spawning before the Fall chums return to the streams. The largest known summer chum population is the Bella Coola River Summer chums. However, a good description of the distribution of Summer chums is apparently not available. The only spawning records in the regions comparing Summer and Fall chum in the same river system have been kept for the Bella Coola River.

4.1 Central British Columbia

Chum salmon in central BC (statistical areas 7 to 11) have been reported in 140 different streams since 1950. The number of streams involved in escapement surveys varies from only 85 in 1950 to 134 streams during the 1980s, but between the 1951-60 decade and 1991-2000 the estimated average escapements have been very similar (Table 4.1). A recent detailed examination of time trends in spawning escapements for these statistical areas demonstrated the high variability in annual escapements, but did not indicate any strong time trends over the years, with the possible exception of chums in Area 11 (Seymour Inlet) and very recent declines in Area 10 (Smith Inlet). These data were presented to the Pacific Scientific Advice Review Committee by Godbout et al. (2003)[8] at the May 2003 meetings. Returns during 2001 and 2002, though, have increased significantly (note that the increased total in Table 4.1 for these two years involved only 84 streams). A portion of this increase may be associated with enhancement programs at Snootli Hatchery (Bella Coola River) and the Nekite River spawning channel. However, the increase in escapements was much broader than just those two locations and was more likely a reflection of improved marine survival for chum salmon and recent reductions in many chum fisheries.

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[8] While the paper was accepted, the revised research document is not yet available for distribution (the paper will be available at the PSARC website: www-sci.pac.dfo-mpo.gc.ca/sci/psarc/).

Table 4.1. Decadal average spawning escapements of central BC chum salmon by time period, and the number of different streams surveyed during each period.

Data are presented by statistical areas of central BC (see Map 1).

Average # of Spawners	1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2002
Area 7	408,000	225,000	237,000	209,000	158,000	188,000	233,000
Area 8	189,000	179,000	164,000	136,000	180,000	196,000	201,000
Area 9	55,200	40,000	32,000	30,100	57,000	25,600	35,700
Area 10	16,500	15,600	13,800	34,000	46,000	18,200	50,000
Area 11		38,000	30,000	44,000	32,000	21,000	36,000
Total CBC	668,700	497,600	476,800	453,100	473,000	448,800	555,700

No. of Streams surveyed	1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2002
Area 7	46	49	46	54	58	56	42
Area 8	27	28	29	31	35	33	23
Area 9	9	12	12	17	20	17	6
Area 10	3	3	3	3	4	4	3
Area 11	0	18	14	15	17	15	10
Total CBC	85	110	104	120	134	125	84

The distribution of spawning population sizes for chum salmon is a combination of a few large populations and a much wider variety of moderate to small populations. For central region chum salmon, very few of the streams are reported to have, on average, more than 10,000 chum spawners. For example, Figure 4.1 presents the average number of chum spawners per population for an early time period (1951-1960) and for the most recent years. Within each period, streams were sorted according to their estimated spawning population size and then ranked from largest (stream 1) to smallest (up to stream 100 in the listing).

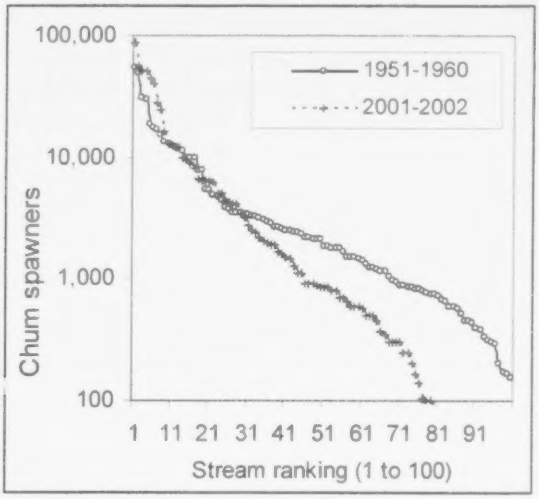

Figure 4.1. Distribution of the estimated chum spawning population sizes by stream for the decade 1951-1960, and for the most recent two years of observations (2001and 2002) in central BC.

In both time periods, only 14 streams were estimated to have over 10,000 chum spawning on average, and the majority of streams with less than 10,000 chums. It is interesting in this example, that during the earlier decade, there were many more streams with larger escapements in the lower range of spawning numbers (i.e., below about 5,000 chums). These are the types of changes that could indicate a reduction in population diversity in chum salmon, but when all the data are further examined, there is little indication of any significant loss of such diversity. In our previous report (PFRCC 2002), plots were presented of the cumulative total number of spawners across streams in a region after ranking the streams from largest to smallest in a time period (diversity plots). The plots curve upwards from the origin and then gradually flatten as the smaller populations are added but have less and less effect on the cumulative total over all streams. For central BC chum salmon, the diversity plot indicates a small shift to the left for the later decades (most pronounced at less than 11 streams, Figure 4.2). But the overwhelming impression from the overlap in these curves is that the distribution of chum between spawning populations (i.e., streams) has changed very little over these 52 years. The shift to the left implies that more of the total escapement is being concentrated in fewer streams. However, the largest change in the figure is the larger number of spawners during the 2001-2002 period. The shape of that curve (dashed heavy line in Figure 4.2) is suggestive of more populations contributing to the total number of central BC chum spawners (i.e., increased distribution of spawners between streams as indicated by shallower curvature, particularly in the moderate-sized populations).

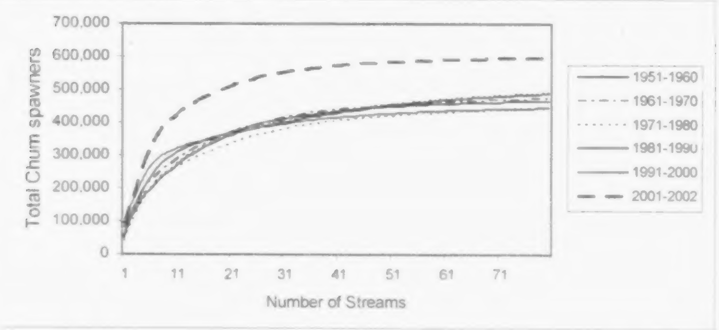

Figure 4.2. Cumulative total spawning escapement by stream for central BC chum salmon.

One line is presented for each time period in the legend. To provide some contrast between time periods only the first 80 streams were plotted in this figure.

A similar message (i.e., few changes) results if the actual streams that contribute the majority of the chum spawning escapement are examined. The ten largest chum systems during the 1951-1960 period contributed 52% of the total number of spawners in central region chum. Of those ten streams, seven remained in the category for the most recent decade (1992-2002). However, in the latter period, the top ten streams account for 69% of the total number of spawners. A portion of this increase will be attributed to the enhancement of Bella Coola chum salmon and the development of the Nekite River spawning channel, but the majority of the streams involved are not enhanced (see Appendix 3, Harvey and MacDuffee 2002). Table 4.2 compares the ten largest streams (based on decadal averages).

Table 4.2. Listing of ten largest chum spawning populations in central BC during two time periods.

The stream ranked first is the largest. If a stream was present during the early period but not listed during 1992-2002, the table notes that stream's rank in the recent period. The total number of streams involved for central BC chum is presented in Table 4.1.

Rank of streams during 1951-1960	Rank of streams during 1992-2002
1. Kainet Creek (Area 7)	1. Bella Coola summer chums, plus additional records for Fall chum (major hatchery)
2. Bella Coola River (Area 8)	2. Kimsquit River
3. Neekas Creek (Area 7)	3. Mussel River
4. Kimsquit River (Area 8)	4. Roscoe Creek
5. Mussel River (Area 7)	5. Kainet Creek
6. Wannock River and Flats (Area 9)... no recent data after 1997	6. Neekas Creek
7. Kwatna River (Area 8) …ranked 19th in later period	7. Nekite River (Area 10, enhanced)
8. Roscoe Creek (Area 7)	8. Elcho Creek Area 8)
9. Taaltz Creek (Area 11) … ranked 11th in later period	9. Chuckwalla River (Area 9)
10. Cascade River (Area 8) … 18th in later period	10. Kitasu Creek (Area 7)

As with pink salmon monitoring, a strength for the chum salmon in central BC has been the consistency of the escapement monitoring in the 140 chum streams. During the 53 years of recorded escapements, over half of these streams have been enumerated in 40 or more years, and only 23 streams have been inspected fewer than 10 times (Figure 4.3). **Given the remoteness of some of the rivers and the local climates, this record of escapement monitoring for central BC chum salmon is exceptional.**

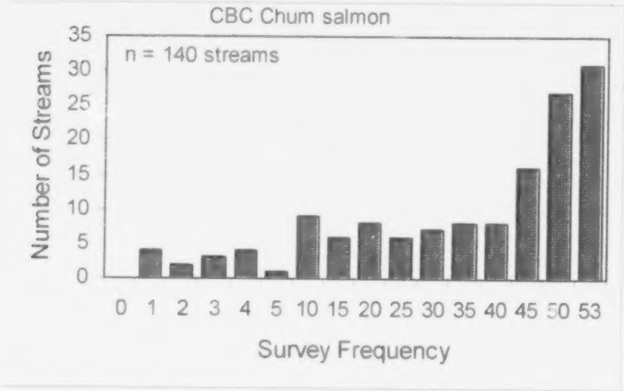

Figure 4.3. Frequency of central BC chum salmon stream surveys since 1950.

Survey Frequency is the number of surveys in the 53 year record. The Frequency axis is not linear, bins 1 to 5 are actual numbers of streams with only 1 to 5 surveys. The remainder of bins are ranges of years inspected (e.g., bin 25 is the number streams surveyed 21 to 25 years out of the 53 year total).

When assessed over time, the pattern resembles the one for central BC pink salmon. The frequency of inspections was very consistent until the most recent period (1991-2000) when pink and chum surveys declined. Unlike the pink figure, Figure 4.4 includes streams that were not surveyed in a particular decade, but have been recorded as having chum salmon during one of the decades. Each period in Figure 4.4 involves 140 streams, but the number surveyed in a period does vary (see Table 4.1). The number of streams not surveyed was excluded in the pink salmon figures; the absence of an inspection may have indicated no inspection or that the stream did not support one year-line of pink salmon.

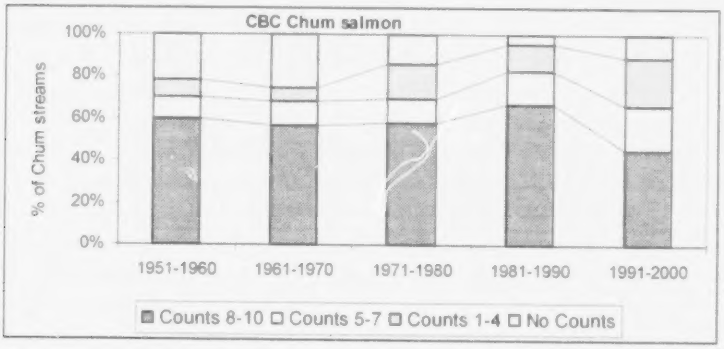

Figure 4.4. Percentage (%) of the streams for central BC chum salmon that have been surveyed 8 to 10 times, 5 to 7 times, or 1-4 times in each decade, and the % of the 140 chum streams that were not surveyed in a decade.

Note that the specific streams surveyed do vary over time but there are 140 chum streams accounted for in each of these decades.

The reduction in frequency of stream surveys during the 1991-2000 period was certainly a change from previous years, but 53 streams were still surveyed at least 8 times in the 10 years and a total of 125 streams were surveyed during that period. The situation deteriorated further during 2001 and 2002. During these recent years, only 41 streams were inspected twice and 45 streams surveyed once (86 streams out of the 140 total), but reasons for these declines were not investigated. It is possible that weather problems, not just budgets, could cause the declines.

While the frequency of escapement surveys does not address concerns about the accuracy of these data, the consistent effort over a long period and large set of streams does add confidence to the relative measures of change in central BC chum salmon. Given the recent increases in spawning escapements and little change in measures of diversity between streams, chum salmon in central BC appear to have maintained their status over this period. Similar results were reported by

Godbout et al. (2003) but their analysis also demonstrated the annual variability in chum salmon production and they provide estimates of total production by chum salmon by statistical areas (see Figure 9 in Godbout et al.).

4.2 Northern British Columbia

Chum salmon in northern BC (statistical areas 1 to 6) have been reported in 470 different streams since 1950. The number of streams involved in chum surveys has varied from only 235 streams in 1950 to 404 streams during the 1980s. Over this period the total estimate of chum spawning escapements has declined from a range of 800,000 to one million to possibly one-half of that range, but the variation in numbers of streams surveyed makes simple comparisons of total escapement of limited value (Table 4.3). A recent detailed examination of time trends in spawning escapements for these statistical areas demonstrated high variability in annual escapements of northern chum and a decline in chum escapements in some northern areas. These data were presented to the Pacific Scientific Advice Review Committee (PSARC) by Spilsted (2003)[9] at the May 2003 meetings.

Table 4.3. Decadal average spawning escapements of northern BC chum salmon by time period, and the number of different streams surveyed during each period.

Data are presented by sub-areas of northern BC (see Map 1).

SubArea	1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2002
Kitimat	199,000	193,000	260,000	156,000	200,000	262,000	221,000
Nass River	3,000	7,000	6,000	14,000	5,000	0	0
North Coast	85,000	94,000	81,000	96,000	63,000	62,000	35,000
QCI	754,000	501,000	480,000	269,000	368,000	275,000	195,000
Skeena River	9,000	9,000	6,000	8,000	8,000	9,000	1,000
NBC total	1,050,000	804,000	833,000	543,000	644,000	608,000	452,000

SubArea	1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2002
Kitimat	93	103	103	98	108	103	60
Nass River	3	7	7	18	11	3	0
North Coast	45	66	61	61	73	61	32
QCI	85	124	143	161	183	186	119
Skeena River	9	13	22	20	29	26	4
NBC streams	235	313	336	358	404	379	215

In an attempt to examine trends in the spawning escapements of specific chum streams, we examined several graphic presentations to provide simple visual portrayals of the data.

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[9] While the paper was accepted, the revised research document is not yet available for distribution (the paper will be available at the PSARC website: www-sci.pac.dfo-mpo.gc.ca/sci/psarc/).

Unfortunately, on a stream-by-stream basis the variation between years and in different streams was so high that only one or two streams could be compared in one plot. Given that there were 470 possible streams to compare, the graphical comparisons at the stream level were simply impractical. However, comparisons at a higher level across streams within each statistical area have already been presented by Spilsted (2003). Concerning escapement trends, Spilsted concluded (figures presented in Spilsted) that:

1. When examined at the Queen Charlotte Islands sub-area level, aggregate chum escapements are variable but relatively stable over the past 30 years; however, within statistical Area 2 East there was a "moderate decline over the time series" (1950-2002).
2. North Coast aggregate escapements (Areas 3,4,5, and 6) and Areas 5 and Area 6 show declines [in spawning numbers] over this time series.
3. Escapements to Area 3 (Portland Inlet and the Nass River) "appear to be generally lower than returns in the 1950s and 1960s"; but Area 4 (Skeena River and outer coast) "does not show a clear trend".
4. The declining trends and current low escapements for Areas 5 and Area 6 are of particular concern.
5. Based on 'average escapement' aggregates for North Coast streams, there is a declining trend over time for streams with average escapements less than 5,000 fish per year; larger stocks did not show this trend.

The distribution of spawning population sizes in the north is similar to that observed in central BC chums, even though there are many more northern streams. For the central region, very few of the streams were reported to have, on average, more than 10,000 chum spawners (see Fig 4.1). Within each period, streams were sorted according to their estimated spawning population size and then ranked from largest (stream 1) to smallest (up to stream 100 in the listing). The same analysis for northern chum (over all sub-areas) is presented in Figure 4.5.

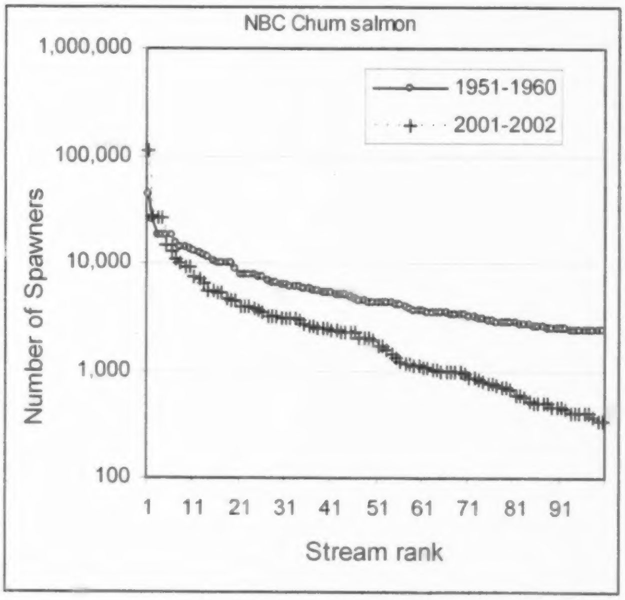

Figure 4.5. Distribution of the estimated chum spawning population sizes by stream for the decade 1951-1960, and for the most recent two years of observations (2001and 2002) in northern BC.

For northern chums during the 1951-60 decade, only 17 of the 313 streams were estimated to have escapements exceeding 10,000 chums. In the most recent period, only 8 of 215 streams were reported to exceed 10,000 spawners including those with hatcheries and enhancement programs. The vast majority of chum streams are estimated to have less than 10,000 spawners (as was also observed in the central region). It is again evident that during the earlier period, many of the streams supported moderate sized populations (1,000 to 10,000 spawners), and that by rank order most spawning populations are smaller in the 2001 and 2002 surveys.

However, what does differ from the central BC chum analyses, is that the diversity plot for chum salmon in the north indicate substantial changes in the distribution of spawning populations sizes in the different decadal periods. In our previous report (PFRCC 2002), we presented plots of the cumulative total number of spawners across streams after ranking the streams from largest to smallest in a time period. The plots curve upwards from the origin and then gradually flatten as the smaller populations are added but have less and less effect on the cumulative total over all streams. Figure 4.6 presents these diversity plots for northern BC chum salmon.

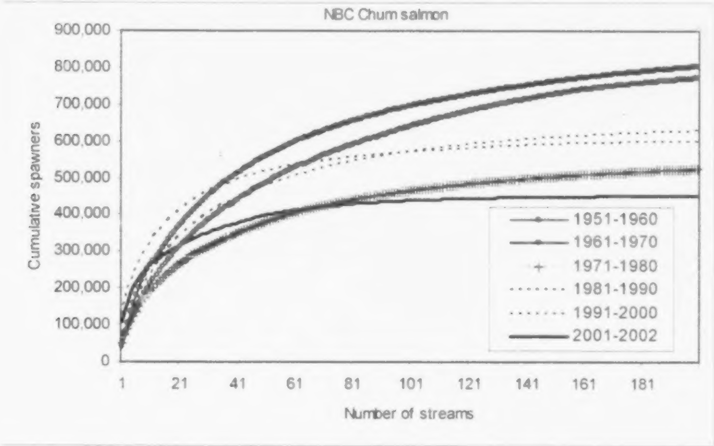

Figure 4.6. Cumulative total spawning escapement by stream for northern BC chum salmon.

One line is presented for each time period in the legend. To provide some contrast between time periods the first 200 streams in the NBC region were plotted in this figure.

The top two curves in Figure 4.6 (1950s and 1960s decades) indicate that many populations contributed to the cumulative spawning numbers. Those curves begin to flatten gradually as more streams are included in the total but continue to rise even at the right margin of the graph. The mid-period plot (1970s, cross hatches) has a much lower cumulative total number of chum spawners, but the shape of that curve is still similar to the earlier periods. During the next two periods (1980s and 1990s, dashed lines), however, the curves shift to the left axis (below 20 streams on the horizontal axis) and flatten as streams continue to be added. These curves indicate that fewer streams are contributing a larger proportion of the total number of spawners and suggest a loss of between population diversity, i.e., smaller numbers of spawners in the remaining streams. These changes continue into the most recent two years (solid black line, lowest cumulative value). The steeper rise in only a few streams may indicate returns to enhancement programs, such as the Kitimat and Pallant Creek hatcheries. The same change in shape could occur though if most moderate- sized populations declined in size over time. The few larger populations could then make up a larger proportion of the total, even if those few had not changed in size. Consequently, while these plots are informative, they do not provide explanations for the changes.

The role of major hatcheries in changing the curve shape is certainly strengthened when the actual streams that contribute the majority of the chum spawning escapement are examined. The ten largest chum systems during the 1951-1960 period contributed 25% of the total number of spawners in northern chum. Of those ten streams, five remain in the top ten streams for the most recent decade (1992-2002). However, in the latter period, the top ten streams account for over 50% of the total number of spawners. Kitimat River and Pallant Creek (Queen Charlotte Islands) alone account for 25% to 30% of the total northern BC chum escapement during the later period, and both involve major hatchery programs. Table 4.4 compares the ten largest streams (based on decadal average escapements) contributing to the northern BC chum salmon resource.

Table 4.4. Listing of ten largest chum spawning populations in northern BC during two time periods.

The stream ranked first is the largest. If a stream was present during the early period but not listed during 1992-2002, the table notes that stream rank in the recent period. The total number of streams involved for northern BC chum is presented in Table 4.3.

Rank of stream during 1951-1960	Rank of streams during 1992-2002
1. Ain River (Area 1, QCI)	1. Kitimat River (hatchery)
2. Lagins Creek (Area 2E, QCI)	2. Pallant Creek (hatchery)
3. Salmon River (Area 2E, QCI) … 15th in later period	3. Kemano River (Area 6)
4. Naden River (Area 1, QCI) … major reduction in 1990s, basis unknown	4. Lagoon Creek (Area 2E, QCI)
5. Kitimat River (Area 6)	5. Deena River
6. Pallant Creek (Area 2E, QCI)	6. Kshwan River (Area 3A, Portland Inlet)
7. Deena River (Area 2E, QCI)	7. Lagins Creek
8. Awun River (Area 1, QCI) … 22nd in later period	8. Foch Creek (Area 6, Kitimat Arm)
9. Mace Creek (Area 2W, nw QCI) … 23rd in later period	9. Ain River
10. Tasu Creek (2W, sw QCI) … 32nd in later period	10. Slatechuck Creek (Area 2E, QCI)

The decline in chum spawning abundance in the Naden River was investigated since the decline was a sudden drop from 8,800 chum, on average, during the 1980s to only 500 chum during the 1990s. Plotting the escapements over time shows, however, that the change occurred between 1988 and 1989, and without any recovery during the 1990s (Figure 4.7). This change in value is co-incident with the first major reductions in program funding and may be associated with a change in survey methods and effort. However, local Fishery staff suggest that the Naden River has been impacted by logging in the upper reaches and extensive flooding in that river and the Davidson River (G. Otto, personal communication, Masset, BC). They believe the reduction to be real and substantial.

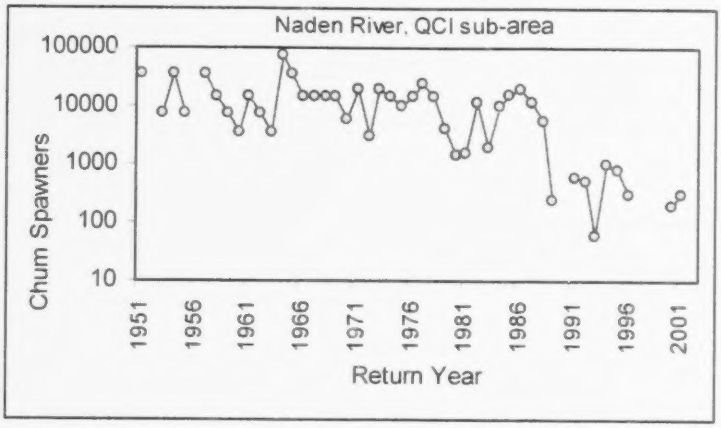

Figure 4.7. Time series of reported chum salmon escapements in the Naden River, Queen Charlotte Islands.

The coverage of escapement surveys between streams and years in northern BC was not as thorough as it was in central BC. However, given the large number of streams involved (470 different streams reported with chum spawning), it may simply be impractical to maintain the coverage compared to 140 central BC streams. Figure 4.8 for northern BC chum streams is a repeat of the Figure 4.3 presented for central BC chum, but there are many more streams with fewer surveys in the north. Using the same comparative standards as for the central region, 149 streams (32% of the total) have been surveyed in over 40 of the 53 years, and 111 streams have been surveyed equal to or less than 10 times (24% of the total).

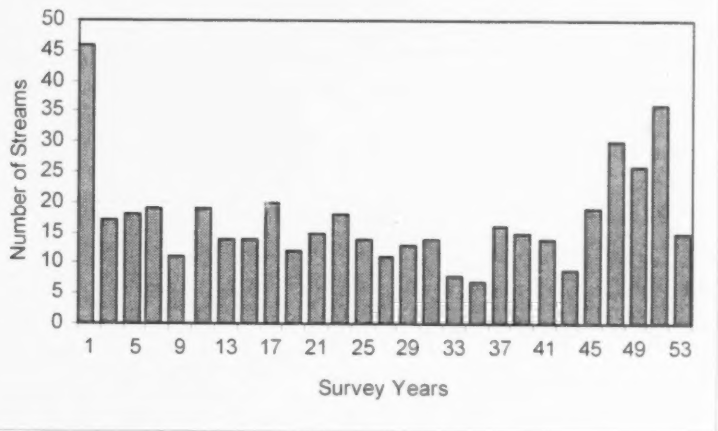

Figure 4.8. Frequency of northern BC chum salmon stream surveys since 1950.

Survey Frequency is the number of possible surveys in the 53 year record. Note: Year = 53 only has one year, each other group is the sum of two years.

However, by those comparisons, 210 streams (45% of the total) have been surveyed between 11 and 40 times over this period. From Figure 4.8, it is apparent that most of the streams in this middle category are actually surveyed in less than half of the years. While these statistics are not as impressive as the central BC coverage, the number of streams with high frequency of surveys (i.e., the 149 streams) does provide an adequate sampling basis for monitoring of northern BC chum, depending on the distribution of the streams and the consistency of the survey methods. Surveys of the remaining streams could be conducted on a less frequent schedule to monitor spatial distribution of the chum and habitat conditions.

The need for a consistent design and set of streams to be surveyed becomes more apparent when the frequency of stream surveys within decades is compared. Data for northern BC chum stream surveys are presented in Figure 4.9, showing that over 40% of the streams surveyed in each decadal period were surveyed eight or more times and in every period over half of the streams were surveyed five or more times (i.e., at least every other year). These summary results do not seem to agree with the data presented in Figure 4.8, yet they are based on the same streams and escapement data sets. As perplexing as this initially seemed, the answer was that there were different streams surveyed in different decadal periods. The number of streams that were not surveyed in the early periods (notice that the streams with no surveys decreased substantially from 1951 to 1990) and streams that were inconsistently surveyed between periods were sufficient for both figures to be correct. However, depending on the questions, one figure may be more useful than the other. For example, if assessment of a stream were most important, then the analysis for Figure 4.8 is more appropriate as it reported the frequency of surveys by stream over the 53 years. But if we were interested in the amount of survey effort expended by time periods, then Figure 4.9 would be more appropriate.

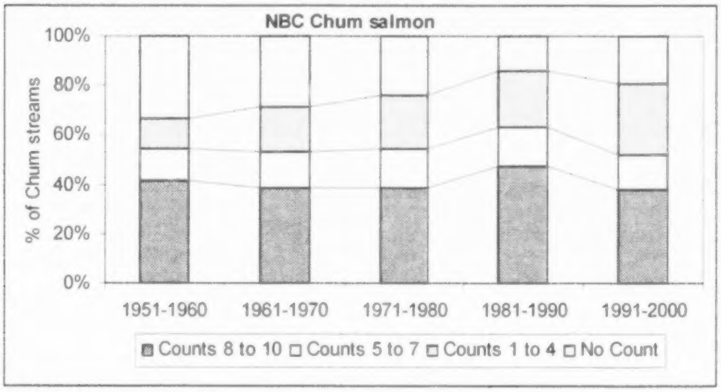

Figure 4.9. Percentage (%) of the streams for northern BC chum salmon that have been surveyed 8 to 10 times, 5 to 7 times, or 1-4 times in each decade, and the % of the 470 chum streams that were not surveyed in a decade.

Note that the specific streams surveyed do vary over time but there are 470 chum streams accounted for in each of these decades.

As with northern pink salmon, the final aspect of the escapement surveys is how they have varied over time and by sub-areas. Figure 4.10 presents the changes in survey frequency by sub-areas and decades for chum salmon in northern BC. The sampling frequency compared in this plot is at least 6 of 10 years surveyed in a stream; the same sampling rate as in the northern pink salmon example.

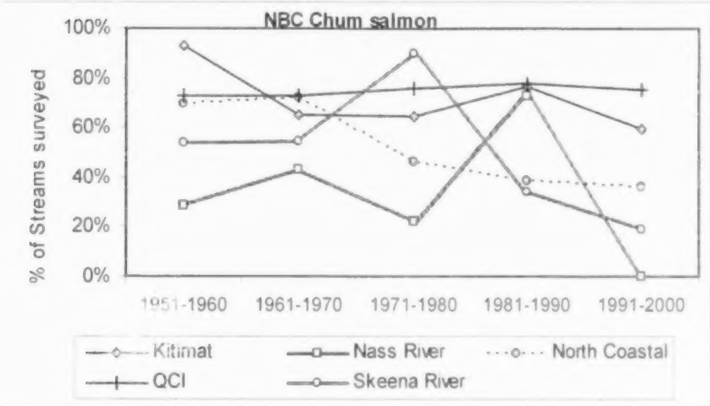

Figure 4.10. Changes in monitoring frequency by sub-areas and decades for northern BC chum salmon.

The plot is the percentage of all streams surveyed (i.e., any stream with an escapement record in a decade) in each sub-area that had at least 6 out of 10 visits in a decade.

One immediate observation from Figure 4.10 is that the sampling between sub-areas has become more variable over time. The most extreme case being the zero incidence of sampling (at this rate) in the Nass River during the 1990s and the decline in sampling in the Skeena River during the 1990s. The number of streams involved in the Nass River is small and the Nisga'a Treaty has substantially changed how surveys are conducted, but according to the government records zero chum salmon have been reported in the Nass River since the 1990s[10]. The other notable observation is the decline in survey frequency for chum streams in the North Coastal streams: from over 70% during the 1960s to under 40% during the 1990s. Sampling frequencies in the Kitimat and Queen Charlotte Islands sub-areas have been very consistent, maintaining between 60% and 80% of the streams being surveyed 6 or more times in each period.

Survey frequency for northern BC chum salmon declined further during the past two years, as presented in Table 4.3. In the Kitimat, North Coastal, and Queen Charlotte Islands sub-areas, the number of streams surveyed was reduced by 40% to 50% relative to the 1991-2000 period, and in the Skeena only 4 streams have recorded escapement surveys for these past two years. No streams have reported chum surveys in the Nass River during these years.

4.3 Chum Enhancement in Central and Northern BC

Chum enhancement activities in this region are quite diversified, involving unmanned spawning channels, numerous small-scale programs managed by local groups, and major hatchery operations maintained by the Salmonid Enhancement Program of Fisheries and Oceans Canada. The variety of programs also results in a mix of strategies and stages of the released fish. Chum salmon migrate to the ocean shortly after emergence from the gravel, so all the strategies involve the release of chum "fry", although these small chum may be unfed at release into freshwater or the ocean, or may be fed for a short period in freshwater (fed fry) or fed in seawater net pens (fed seapen). The vast majority of the releases are associated with the Snootli Hatchery (Bella Coola River), Kitimat Hatchery (Kitimat), and the Pallant Creek Hatchery (Cumshewa Inlet, Area 2E).

In central BC, pilot programs for the Snootli Hatchery released unfed chum fry into Snootli Creek beginning in 1979 (1978 brood year) and production increased rapidly as the hatchery developed (Figure 4.11). Other chum salmon programs in the central region include sea-pen releases of fed-fry by the Keiltsuk and from the Klemtu Creek hatchery. These other programs contribute between 15 and 25% of the chum released from a brood year (i.e., spawning year).

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[10] Note that this observation is not contained in Spilsted (2003) as he did not separate the Nass River from the coastal rivers of Area 3A, Portland Canal.

In northern BC, pilot projects for the Pallant Creek Hatchery also began releasing fry in 1979, including three types of releases (unfed fry, fed fry, and seapen reared). Releases from the Kitimat Hatchery began in 1982 and have since provided fry in several rivers in the Kitimat area (Bish Creek, Dala River, Hirsch Creek, Kildala River, and the Kitimat River). Other smaller-scale programs have occurred throughout the Queen Charlotte Islands, the Skeena River (mostly in the Kitsumkalum River), and in the Kincolith River (near the mouth of the Nass River). However, these releases are overwhelmed by the releases from two major hatchery programs and the recent expansion of sea-pen releases from Pallant Creek Hatchery (Figure 4.12).

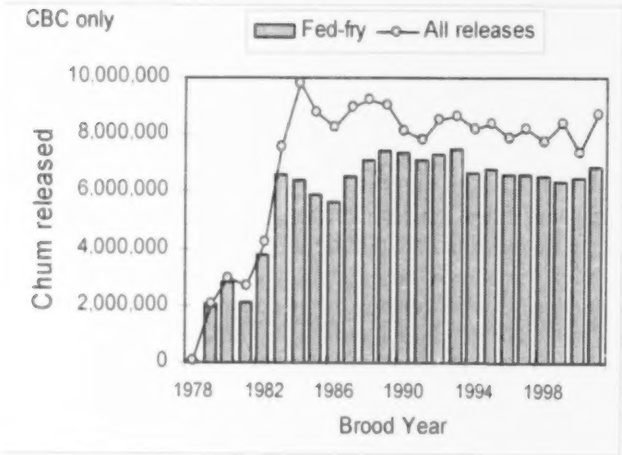

Figure 4.11. Numbers of chum salmon released in central BC since the 1978 brood year.

Vertical bars are releases of chum fed-fry from Snootli Hatchery. The line and dots are the release of all stages of chum salmon from all chum enhancement programs in central BC.

Some limited marking of chum releases has been conducted, including fin-clipping and coded-wire tagging, but these data were not examined for this report. Reports on enhancement were included in the recent reports that were cited above: Godbout et al. (2003) and Spilsted (2003).

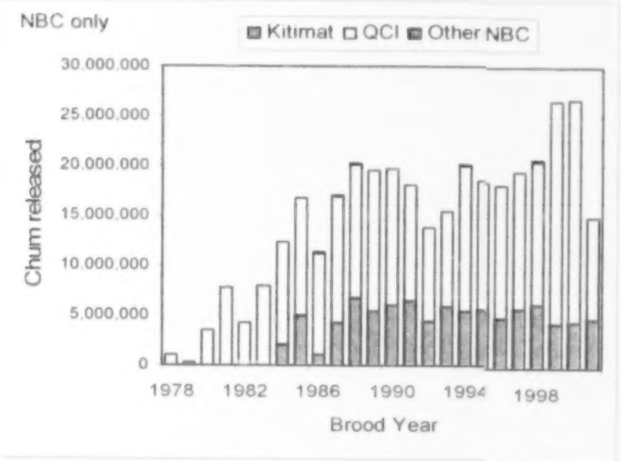

Figure 4.12. Numbers of chum salmon released in northern BC since the 1978 brood year.

Vertical bars are releases of chum from the Kitimat Hatchery and Pallant Creek Hatchery. The releases from these two major facilities are cumulative in this figure. Releases from other facilities in northern BC are included but are overwhelmed by the two hatcheries. Other northern BC chum releases contribute 1% or less of the annual total released.

4.4 Chum Salmon Summary

Chum salmon in central BC (statistical areas 7 to 11) have been reported in 140 different streams since 1950. The number of streams involved in escapement surveys varies from 85 streams in

1950 to 134 streams during the 1980s, but between the 1951-60 and 1991-2000 the estimated average escapements have been very similar (Table 4.1). The distribution of spawning population sizes for chum salmon is a combination of a few large populations and a much wider variety of moderate to small populations. For central BC chum salmon, very few of the streams are reported to have, on average, more than 10,000 chum spawners.

As with pink salmon monitoring, a strength of the central BC chum salmon has been the consistency of the spawning escapement monitoring between years. During the 53 years of recorded escapements, over half of these streams have been enumerated 40 or more years, and only 23 streams have been inspected less than 10 times (Figure 4.3). Given the remoteness of some of the rivers and the local climates, this record of escapement monitoring is exceptional. When assessed over time, the frequency of inspections was very consistent until the most recent period (1991-2000) when the same change was observed for pink salmon in this region.

While the frequency of escapement surveys does not address concerns about the accuracy of these data, the consistent effort over a long period and large set of streams adds confidence to the relative measures of change in central BC chum salmon. Given the recent increases in spawning escapements and little change in measures of diversity between streams, chum salmon in the central region appear to have maintained their status over this period. Similar results were reported by Godbout et al. (2003) but their analysis also demonstrated the annual variability in chum salmon production and accounted for estimates of total production by chum salmon by statistical areas (see Figure 9 in Godbout et al.).

In northern BC (statistical areas 1 to 6), chum salmon have been reported in 470 different streams since 1950. The number of streams involved in chum surveys has varied from 235 streams in 1950 to 404 streams during the 1980s. Over this period the total estimate of chum spawning escapements has declined from as much as one million to possibly one half of that level, but the variation in numbers of streams surveyed makes simple comparisons of total escapement of limited value (Table 4.3). A recent detailed examination of time trends in spawning escapements for these statistical areas demonstrated the high variability in annual escapements of chum salmon and a decline in chum escapements in some areas (Spilsted 2003). Very few of the chum streams in the north are reported to have more than 10,000 chum spawners per year, on average. In contrast with the central BC chum analyses, the diversity plot for northern chum salmon indicates substantial changes in the distribution of spawning population sizes in the different decadal periods. The total number of spawners has declined, but a few streams involved with major hatcheries now contribute a large proportion of the total, and the number of medium to small populations contributing has declined in numerical importance.

The coverage of escapement surveys between streams and years in northern BC is not as thorough as in central BC. However, given the number of streams involved (470 different streams reported with chum spawning), it may simply be impractical to maintain the coverage given to the large number of streams. Using the same comparative standards as those used for the central region, 149 streams (32% of the total) have been surveyed in over 40 of the 53 years, and 111 streams have been surveyed equal to or less than 10 times (24% of the total). The number of streams with high frequency of surveys (i.e., the 149 streams) could still, however, provide an adequate sampling basis for monitoring of northern BC chum. One immediate concern in the north (from Figure 4.10) is the increased variability in escapement sampling between sub-areas and the reduction in number of streams monitored. Survey frequency for those chum salmon declined further during 2001 and 2002 (Table 4.3.).

The status of northern BC chum salmon is much more difficult to summarize than for their central BC counterparts. The status of northern chum is more variable between sub-areas with reductions in escapement numbers and stream diversity likely in the Nass River, Skeena River, and areas of the Queen Charlotte Islands. Analyses by Spilsted (2003) suggest that these changes are related to stream size with changes most evident in chum populations that were typically 5,000 spawners or less.

4.5 Council Discussion

Chum salmon in central and northern BC are also a rich salmon resource that reportedly utilizes over 600 streams. However, the members of the PFRCC are less confident about the status of chum salmon than pink salmon. The information from central BC supports a positive outlook, but the poorer quality of information about chum salmon stocks in northern BC is a cause for uneasiness about the actual abundance and the extent of diversity in some sub-areas. Many of the comments presented in section 3.4 on pink salmon are also relevant for chum salmon. Our sense of northern and central region chums from this review is that we may be missing the important changes in these stocks by not examining them more thoroughly at a watershed level and particularly for the moderate to smaller sized populations. **Given how few major chum populations (i.e., over 10,000 spawners on average) are estimated in both central and northern BC, the real basis of the chum salmon resource is the diversity and status of the medium to smaller systems.**

In southern BC, many chum fisheries have moved to more terminal locations and allowed managers to target hatchery-based populations. Terminal fisheries for fall chum returning to Pallant Creek Hatchery are a similar example in the north. **However, the Council notes that summer chum populations in the central and northern BC may be a much more difficult management challenge.** Summer chum salmon are present in coastal fishing areas through July and August (Table 7 in Spilsted 2003) and will be caught incidentally during sockeye and pink salmon fisheries. However, without more specific information on the run-timing of chum populations and vulnerability to fisheries (i.e., migration routes, holding areas, etc.) the harvest impact of this by-catch is unknown. The concern has been raised by fishery managers that summer chum salmon could have a relatively low productivity and the impact of by-catch could be significant. Without more quantitative assessment, these concerns cannot be evaluated. To begin this process, the Council recommends that each chum population in the central and northern regions be designated by run-timing. If more than one run-type exists in a stream, the Fisheries and Oceans Canada escapement records should allow for separate reporting of the escapement size.

While there has been extensive effort by Fisheries and Oceans Canada personnel to maintain escapement records for chum salmon in the central and northern BC, the Council again recommends the establishment of an explicit assessment framework that focuses these efforts in an efficient and informative monitoring program. In both regions, the high frequency of monitoring in a significant number of chum spawning streams provides an important basis for development of this framework. Future design work can build from these efforts and should include studies of the comparability of past and proposed survey methods. Furthermore, chum salmon have multiple ages at maturity, so any assessment program for such species must involve sampling for age classes, although this has seldom been done consistently.

Finally, the Council has noted the inability to assess harvest impacts on chum salmon, in particular, the Summer chum salmon. If Summer chum were shown to be genetically different from Fall chum, concern about the impact of fishing on the conservation of Summer chum salmon could easily be anticipated. **The Council would strongly recommend that Fisheries and Oceans Canada establish some quantitative capacity to assess Summer chum salmon for the estimation of variation in marine survival, fishery harvest impacts, and limits to the productivity. The risk to Summer chum salmon by fishing impacts can not be assessed without the development of some indicator stocks for these salmon.**

5.0 COHO SALMON (*ONCORHYNCHUS KISUTCH*)

Coho salmon are the most widely distributed of the Pacific salmon in central and northern BC. Escapement records list 745 streams with coho spawning noted since 1950. These numbers are likely to even be conservative since the mid to late autumn spawning of coho makes their visual enumeration difficult.

Coho or Silver salmon

Consequently, their spawning numbers and distribution are almost certainly under-estimated. For the same reasons, our ability to assess this species is very limited, especially in quite remote watersheds. While Fisheries and Oceans Canada maintains annual escapement monitoring, the accuracy of these programs is acknowledged to be limited and the records do not provide an adequate basis for any quantitative assessment of coho population status. Assessment of coho salmon relies on more quantitative measurement in selected streams that are referred to as indicator streams or stocks. The uses of indicator stocks was described for southern BC coho in our initial report in this series (PFRCC 2002) . Unfortunately, there are no indicator stocks programs in central BC or on the Queen Charlotte Islands, but there are four in northern BC.

5.1 Central British Columbia

Coho salmon escapements have been reported in 138 different streams in the central region, but the maximum surveyed in a decade is only 109 (Table 5.1). The majority of the spawners are in the Bella Coola River system (Table 5.1, Figure 5.1). Between 1950 and the early 1990s, the reported Bella Coola escapement of coho salmon accounted for 50% of the total Area 8 escapements, increasing to about 80% recently. The numbers of coho salmon reported seem modest compared to the other salmon species but, as noted above, the data likely only represent major trends in coho production, not actual abundance. The plot of escapements of Bella Coola River coho provides a basis for a few points about the trends in central BC coho:

- The early years of data (1950-1966) are represented by only three values (15,000, 35,000, or 75,000). Early records reported escapement within ranges of values (each range was identified by a letter "grade"). The three values in this figure are repeated because they are mid-points of three ranges.
- Between 1967 and 1997, coho returns fluctuated from low to mid-range values but, on average, showed a continued decline in escapements until 1998.
- Returns in recent years have increased, but substantially more in one year-line than the other two. The vast majority of coho mature at three years of age and result in three largely

independent return lines, with the exception of the Age-2 "jack" males that do cross between years.

Table 5.1. Average spawning escapements by decade for central BC coho salmon, and the number of different streams surveyed during each period.

Data are presented by statistical areas of central BC (see Map1)

Average # of Spawners	1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2002
Area 7	12,600	24,700	19,900	10,900	3,700	4,500	8,600
Area 8	68,200	84,000	80,000	49,000	33,900	31,000	70,100
Area 9	10,600	9,700	11,400	8,900	8,100	11,100	250
Area 10	3,000	2,800	3,400	2,100	1,700	7,500	12,800
Area 11		15,300	7,400	2,700	2,800	11,400	18,900
Total CBC	94,400	136,500	122,100	73,600	50,200	65,500	110,650

No. of Streams surveyed	1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2002
Area 7	24	43	39	39	50	35	11
Area 8**	20	24	22	23	21	13	9
Area 9	10	14	20	21	21	7	1
Area 10**	5	6	6	6	4	3	1
Area 11		16	14	15	13	21	16
Total CBC	59	103	101	104	109	79	38

*** Coho escapement are recorded into artificial spawning channels constructed for other species, the Atnarko channel (Area 8) and the Nekite channel (Area 10).*

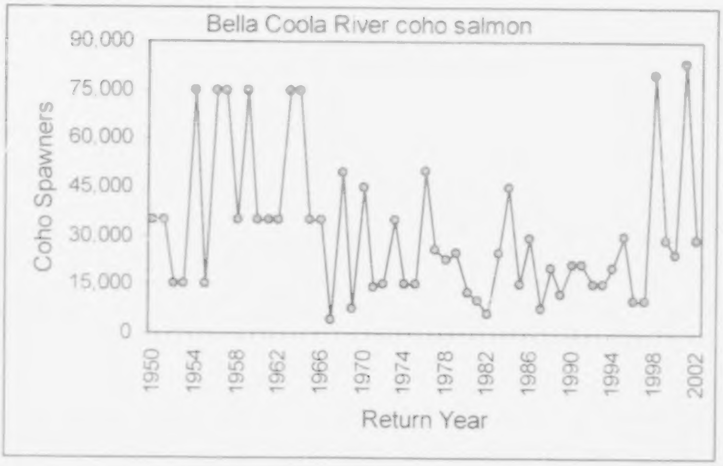

Figure 5.1. Records of coho salmon escapement estimated in the Bella Coola River (Area 8).

Data from Departmental records for Bella Coola system, 1950 to 2002.

In other areas of British Columbia, assessment of coho salmon relies on coded-wire tagging of indicator stocks and quantitative estimation of the spawning escapements, usually via counting coho past fences. **However, there are presently no indicator stocks for coho salmon in the**

central BC region. Recently, Fisheries and Oceans Canada has been examining the Martin River as a potential indicator stock. This stream is located in Area 8 near Ocean Falls and could provide a useful index of coho production. Escapements to the Martin River have been consistently monitored and the range of returns provides adequate contrast for detecting change over time (Figure 5.2).

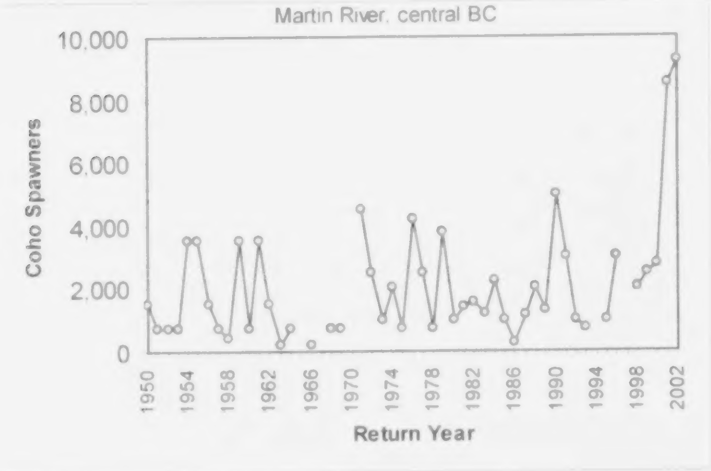

Figure 5.2. Records of coho salmon escapement estimated in the Martin River (Area 8 near Ocean Falls), Departmental records for 1950 to 2002.

Indicator stocks, or streams, for coho salmon provide important information based on tagging (discussed below), but should also provide a representative index of annual changes in spawning escapements in a geographic area. This latter point is the basis for establishing index stocks in other species. If this were true for the Martin River, the escapements should also increase in other Area 8 streams when they increase in the Martin. To contrast these escapement trends, annual returns to the Martin River were compared with annual returns to the Bella Coola River and to the remaining Area 8 streams (based on total Area 8 coho escapements minus the Bella Coola River and the Martin River). Comparing these trends on one graph can be difficult simply due to the large differences in the size of the numbers. For example, how can we present an informative comparison of stream with a few hundred coho versus a large river with tens of thousands of coho? To compare trends over time, annual returns within the Martin River, Bella Coola River, and other Area 8 (all streams combined) were standardized so that they varied about zero (standardized normal deviations). To make the Bella Coola and Other Area 8 values relative to the Martin River values, the annual standardized value for the Martin River was subtracted from each of the others (Figure 5.3). In figure 5.3, the deviation of the Bella Coola or "Others" value from zero is a measure of how different those returns were compared to the Martin River. Ideally, the values should vary about zero without any patterns. This would indicate that Martin River was a good indicator, on average and over time, and representative of Area 8 coho salmon returns.

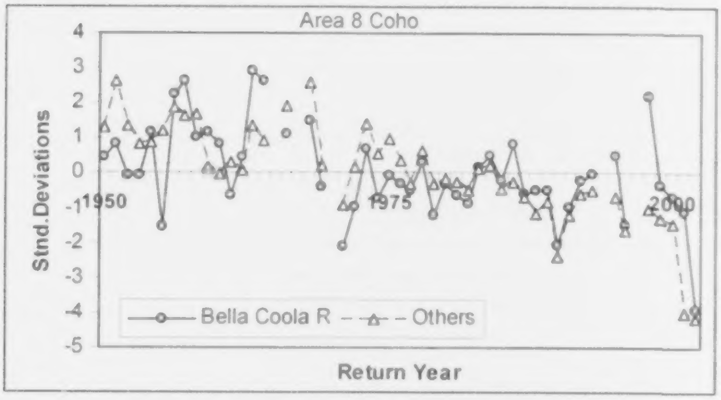

Figure 5.3. Time trend of coho salmon escapements in the Bella Coola River and Other Area 8 streams relative to the annual returns to the Martin River, 1950-2002. *Years without data in Martin River are excluded from this comparison. Stnd Deviations are actually standardized normal deviations calculated by year and subtracting Martin R.*

The period previous to 1970 shows quite consistent positive deviations in both the Bella Coola and Others data, indicating that returns to the Martin River did not "represent" the Area 8 very well. However, after 1970 the representation improves until some large deviations in 1998, 2001, and 2002. The large deviation for the 1998 Bella Coola River value indicates that it was atypical of returns to the Martin and to the Others. In 2002, the large negative deviation in Others indicates that they differed from Martin and the Bella Coola River. And, the 2002 value indicates both the Bella Coola and Others differed from the Martin River return. In general, these data suggest that the Martin River could be a reasonable indicator but there should be some concern for the changes in recent years. There are a few possible reasons that would have to be examined, including returns of the enhanced coho to the Bella Coola River, and changes to spawning escapement surveys in the other Area 8 coho streams in recent years (discussed below).

The other aspect of coho indicator stocks is the coded-wire tagging of juveniles. Other than the Martin River, there are populations associated with enhancement programs that have been tagged for enhancement evaluation and monitoring. These populations provide useful information on distribution of these coho populations in ocean fisheries (Table 5.2) and run timing of returning adults. However, without quantitative monitoring of the spawning escapements, the major value of tagging for stock assessment cannot be derived, i.e., estimation of annual marine survival and direct estimates of fishing impacts.

Table 5.2 presents the ocean distribution of coho salmon that have been tagged in central and northern BC enhancement and assessment programs.

Data used in this summary table were collated from the mark-recovery database at the Pacific Biological Station, Nanaimo, BC. All recovery data for the spawning years (1981-1992) were summed within each tagged population and the average distribution for this period calculated. More recent years were not included due to closures in Canadian fisheries after 1995. This table is not intended to present all tagging sites but a range of programs from Portland Inlet south to the Bella Coola River.

The fisheries included in this summary are: Southeast Alaskan fisheries, all gears; Northern Troll gear (commercial hook-and-line) in BC statistical areas 1 to 5; Northern Nets, including seine or gill nets in BC statistical areas, areas 1-5; Central Troll gear in BC statistical areas 6-11; Central Nets seine or gill nets in central BC statistical areas 6-11; marine sport, including recreational fisheries throughout north and central BC; freshwater sport fishing (locations that depend on the tagged population, including recoveries in freshwater portions of the natal or return stream); and Other fisheries that include any recoveries outside of the listed fisheries. Catch distributions are used as an indication of the ocean distribution of the tagged stock, but it can be misleading due to changes in fisheries over time, and by the use of percentages. For example, there were significant recoveries in the Central Net fisheries from the Heiltsuk program that may indicate a terminal harvest on these returns. However, the effect of these terminal area recoveries is that the ocean recoveries contribute a lower proportion of the total. This does not mean though that the Heiltsuk coho were not prevalent in those outer fishing areas. Interpretation of these distributions requires examining the fishery catch and effort statistics and the timing of the fisheries. In general, it is well accepted that northern and central BC coho are vulnerable to fisheries in SE Alaska, and the extent of their vulnerability to Canadian fisheries is dependent on the location of the natal stream. For example, recoveries of the Kincolith, Lachmach, Fort Babine, and Toggagan Creek programs are very infrequent in central BC fisheries. These coho all originate in the Skeena River and north, and their distribution does not expose them to fisheries in more southerly locations.

Examples of more quantitative information resulting from coded-wire tagging programs will be discussed in the northern BC coho section since all of these results relate to indicator stocks in that area.

For the most recent information on assessments of escapement trends and abundance forecasts for central BC coho salmon, see Holtby et al. (2002) and Simpson et al. (2003).

Table 5.2. Distribution of coded-wire tag recoveries for ten coho salmon populations in central and northern BC.

Each distribution is based on the sum of 10 years of tag recovery data for each stock and expressed as a percentage of the total number of CWT recoveries for each population. All recoveries are based on releases from spawning years between 1981 and 1992 (varies between populations), the sum of each row is 100%.

Population	SE Alaska (all gears)	Northern Troll (A1-5)	Northern Nets (A1-5)	Central Troll (A6-11)	Central Nets (A6-11)	NCBC Marine Sport (Areas 1-11)	Freshwater Sport (natal stream area)	Other Fisheries
Kincolith River (upper Portland Inlet)	60.7%	29.2%	7.0%	0.6%	0.1%	0.7%	1.3%	0.4%
Lachmach River (Work Channel)	55.6%	30.3%	12.5%	0.2%	0.3%	0.9%	0%	0.2%
Fort Babine, Babine Lake	56.1%	30.4%	11.8%	0.2%	0.3%	0.7%	0.3%	0.2%
Tobbogan Creek, interior Skeena River	42.6%	27.0%	21.2%	0.1%	0.7%	0.3%	7.5%	0.6%
Kitimat River, Kitimat Arm	36.8%	38.1%	7.1%	1.6%	9.7%	1.6%	4.6%	0.5%
Yakoun River, Masset QCI	18.3%	72.3%	4.8%	0.3%	0.1%	4.0%	0%	0.2%
Pallant Creek, lower Areas 2E, QCI	4.3%	45.1%	19.2%	0.5%	0.1%	26.4%	3.5%	0.9%
Hartley Bay Creek, lower Douglas Channel	57.2%	29.6%	6.2%	1.3%	3.7%	1.7%	0%	0.3%
Heiltsuk, McLoughlin Bay	17.4%	12.3%	4.8%	3.7%	58.5%	1.5%	0%	1.8%
Snootli Creek, Bella Coola River, Area 8	40.9%	31.7%	4.9%	7.3%	7.1%	2.8%	1.1%	4.2%

The difficulty in conducting escapement surveys for coho salmon in central BC is clearly indicated in the frequency of survey coverage since 1950. Unlike central BC pink and chum salmon surveys, the vast majority of coho streams in this region have recorded escapements in less than half of the years (Figure 5.4). Only the Bella Coola River has been surveyed each year and the Martin River has surveys in 48 years of 53 total years.

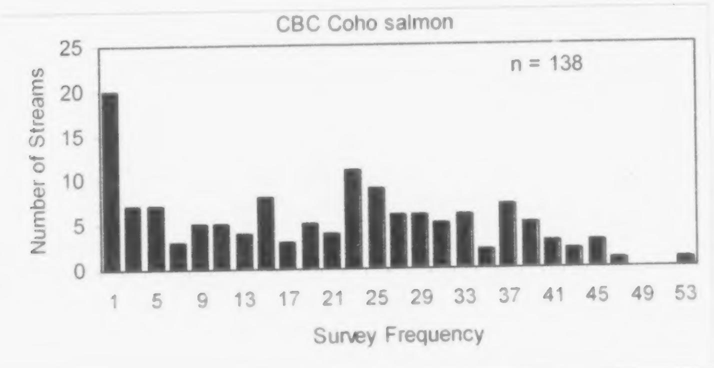

Figure 5.4. Frequency of stream surveys (number of different streams with at least one record of coho spawning = 138) since 1950.

The categories for Survey Frequency include 2 years each (i.e., category 1 includes 1 or 2 years of records; but category 53 only has one year).

This difficulty in conducting coho escapement surveys in a relatively remote location and in mid-fall is the reason why escapement summaries must be considered with caution as indicators of coho salmon status. The distribution of spawning population sizes between streams was quite consistent until the escapements began to decline in the 1980s. Between 1950 and 1980, the ten largest coho streams (based on decadal average values) accounted for 62% to 66% of the total escapements. During the 1980s and 1990s, though, the top ten streams accounted for 73% to 80% of the totals. The shapes of the curves show the expected shift to the left, but most of this shift is accounted for by the Bella Coola River alone. A significant portion of this increase was due to coho production from Snootli Creek Hatchery.

The changes in distribution may also be confounded by significant decreases in the number of streams that have been inspected over time. Unlike chum and pink salmon, the number of inspections of streams has not been maintained for central BC coho. The reduction in survey effort likely reflects the poor quality of data derived and budget limitations, but the decline in coverage does complicate assessment of escapement trends.

The decrease in surveys has now become a significant limitation to broad or generalized assessments: their future use will require more selectivity about which streams are assessed . Since the 1970s, less than half of the known coho streams have been surveyed in five or more years in each decade, and by the 1990s only 23 streams were surveyed five or more years (Figure 5.5).

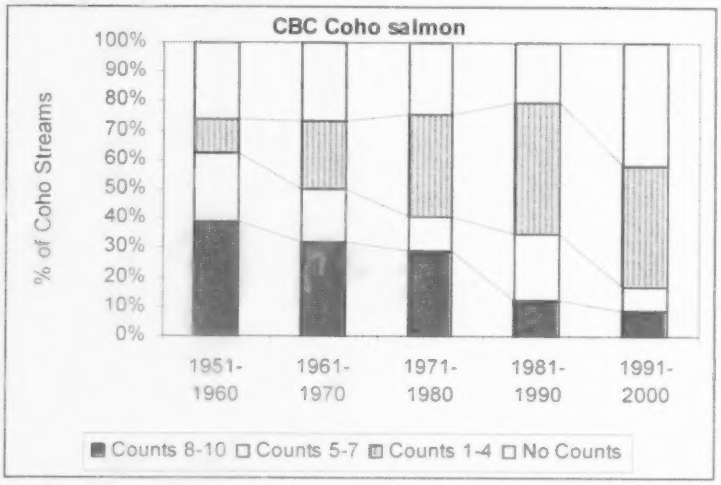

Figure 5.5. The percentage (%) of central BC coho streams that have been surveyed 8 to 10 times, 5 to 7 times, or 1-4 times in each decade, and the % of the 138 streams that were not surveyed in a decade.

Note that the specific streams surveyed vary over time but there are 138 streams accounted for in each of these decades.

The reduction in surveys has apparently continued during 2001 and 2002. Only 11 streams were survey in both years and 29 streams in one of the years. The decline to only a few surveys is worrisome if people hope to consider coho salmon status or spatial distributions. But, if budgets are limited and the data quality that will be derived is poor, then directing assessments of a sub-set of streams may be more informative. Clearly, the increased abundance of coho in these recent years has been detected in these few streams but how representative these results are depends upon how the sub-set of streams was determined.

5.2 Central BC Coho Enhancement

Coho enhancement is wide spread in British Columbia but there are only a few significant programs in the central region. The majority of production comes from the Snootli Creek Hatchery, but two other programs include the release of sea-pen smolts from the Heiltsuk facility (McLoughlin Bay) and smolts and sea-pen smolts from Klemtu. Strategies for releasing coho salmon from facilities are numerous. Since coho salmon typically remain in freshwater for a year or more, culture programs may release juveniles throughout their first year or hold them until they are ready to migrate as smolts to the sea, usually in May through June at about 1.5 years after spawning. Coho released to freshwater streams as fry may be unfed or fed before release and at various times of the year, most frequently in the spring or fall. Other enhancement programs transfer the coho to net pens in saltwater (sea-pen rearing) and feed them before release. The relative survivals of the release strategies are not well monitored, but it is generally accepted that large coho survive better than smaller ones. To summarize the release data for central BC coho, all types of fry releases (fed or unfed) have been included as "Under-yearlings", and all types of smolt releases (freshwater or sea-pen) are referred to as "Smolts 1+" (1+ indicates that a smolt is over 1 year-of-age, Figure 5.6). For example, if a coho spawned in the fall 1998, the fry would emerge from the gravel the following spring and rear in freshwater for that year (1999 in this example, as coho grow in freshwater they may also be call "parr"). The fry or parr would typically over-winter in the freshwater stream and then emigrate to the sea in the late spring of the following year (2000 in this example).

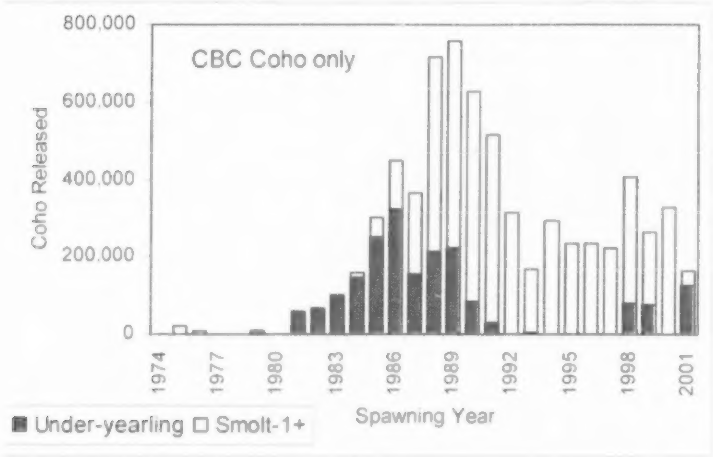

Figure 5.6. Releases of coho salmon from all enhancement programs in central BC, for spawning years 1974 through 2001 (2001 releases may be incomplete at this time).

Fry releases occur in the year after spawning, and smolt releases 1.5 years after spawning

Recoveries of coho salmon tagged at the Klemtu and Heiltsuk projects may provide a measure of the proportion of coho returns attributed to the enhancement projects in those local areas, but no quantitative measure of enhanced returns is otherwise available. Returns of coho salmon to the Atnarko River (Bella Coola River system) are counted past the Atnarko counting tower until late October, but the proportion of the run resulting from hatchery rearing is not estimated. Sampling of coho carcasses can provide an estimate of the tagged-to-untagged ratio, but the untagged fish may be from the hatchery or produced naturally.

5.3 Northern British Columbia[11]

Coho salmon escapements have been reported in 607 different streams in the north, but typically only about two-thirds of these streams have been surveyed in a decade (Table 5.3). Coho are widely distributed with the exception of the Nass River where coho streams are more limited, although the average number of coho recorded per stream has been comparable to other northern streams.

Table 5.3. Decadal average spawning escapements of northern BC coho salmon by time period, and the number of different streams surveyed during each period.

Data are presented by sub-areas of northern BC (see Map 1)

SubArea	1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2002
Kitimat	63,000	109,000	111,000	51,000	55,000	63,000	43,000
Nass River	1,000	6,000	33,000	24,000	25,000	7,000	14,000
North Coast	19,000	58,000	88,000	40,000	44,000	25,000	22,000
QCI	61,000	104,000	135,000	115,000	55,000	58,000	60,000
Skeena River	41,000	104,000	94,000	52,000	41,000	42,000	88,000
NBC total	185,000	381,000	461,000	282,000	220,000	195,000	227,000

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[11] The most recent publication of PSARC on northern coho salmon is: Sawada et al. Forecast for Northern British Columbia coho salmon in 2003. PSARC Res. Docu. 2003/064.

SubArea	1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2002
Kitimat	84	99	95	86	109	85	39
Nass River	3	6	14	32	34	14	7
North Coast	41	65	71	82	95	61	20
QCI	61	109	113	122	170	159	80
Skeena River	46	67	92	89	99	101	62
NBC total	235	346	385	411	507	420	208

Table 5.3 suggests a significant decline over time in the number of coho salmon returning to spawn in the northern BC region, even with the increased number of streams surveyed in the later decades. This trend is also evident when two of the largest coho systems are compared over time (Figure 5.7). The Lakelse River (Skeena River) and the Tlell River (Area 2E, Queen Charlotte Islands) were the two streams with the largest decadal average number of coho salmon between 1951-1960, and they were the third and fourth largest between 1991-2000 (Kitimat and Yakoun rivers were larger in the 1991-2000 period, but both of those rivers involve coho enhancement). The Lakelse and Tlell rivers showed a reduction in coho spawning escapement during the early 1970s with a greater initial decrease in the Lakelse River. Reported escapements were less variable in the Tlell River but continued to decline until their lowest point in 1990. Following a period of increasing escapements in the Lakelse, the mid-1990s saw a significant reduction until the lowest recorded coho escapement during 1997. The 1997 escapement of coho salmon to the Skeena River was the lowest recorded since 1950, leading to the closure of Canadian coho fisheries in central and northern BC. After 1997, coho escapements began to improve in both systems. Recent increases in the coho escapements were also noted in Table 5.3, but note that the minor increase in total northern BC coho escapement during 2001-2002 was recorded from only half of the streams surveyed in previous decades.

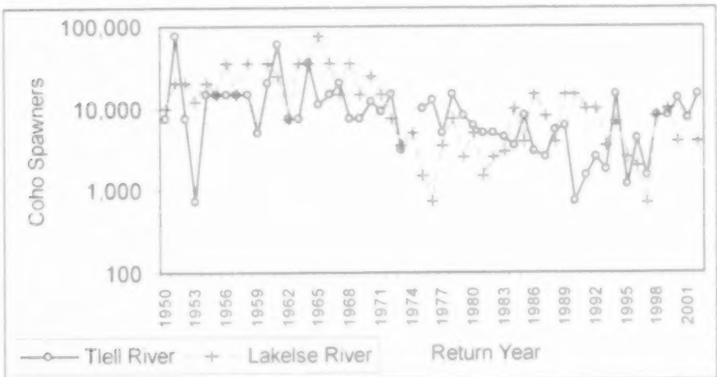

Figure 5.7. Annual reported coho salmon spawning escapements to the Lakelse River and Tlell River since 1950. *These two rivers were selected as examples of the escapement trends since they were the streams with the largest coho escapements during the 1951-1960 decade and continue to be amongst the largest currently.*

The trends in these rivers can also be compared to a standardized test fishery[12] that has been conducted at Tyee in the lower Skeena River since 1956. This program is conducted to monitor annual variations in escapement of Pacific salmon and steelhead to all areas of the Skeena above the test fishing site. The gillnet fishery is standardized by gear, fishing location, and times (tidal conditions) and provides a daily index of catch per day by species. The annual index of returns is the sum of each daily index (Figure 5.8). This program provides an annual measure of return strength by species (during the fishing season) and is independent of the visual escapement surveys.

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[12] For a description of the fishery see: www.pac.dfo-mpo.gc.ca/northcoast/skeena/tyeetest.htm

The poorest test fishery result for Skeena coho salmon occurred in 1997 when the cumulative total of the daily catch indices was only 5.2 for the entire year. The severity of the 1997 value is put in historical context in Figure 5.8.

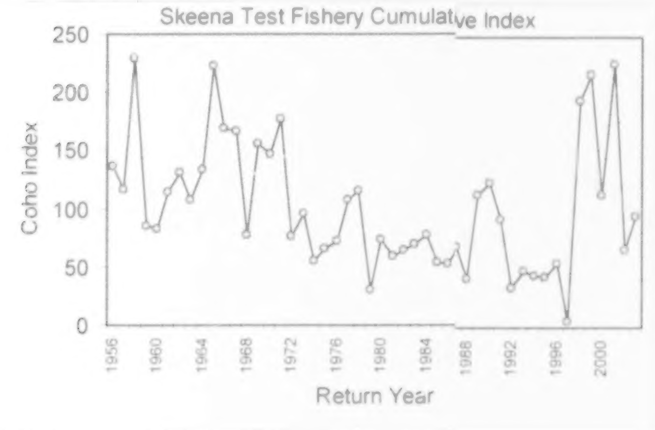


Figure 5.8. Time series of the annual cumulative Skeena test fishery index for coho salmon, 1956 to 2003.

Data provided by Fisheries Operations, DFO, Prince Rupert, BC

If the test fishery were an informative index of the spawning escapement, then the relationship between the cumulative annual index and the total coho spawning escapement for that year in the Skeena River should be linear. Figure 5.9 relates the annual cumulative coho index from the test fishery (excluding data for 2003) to the reported coho spawning escapement in the Skeena River (Area 4 total).

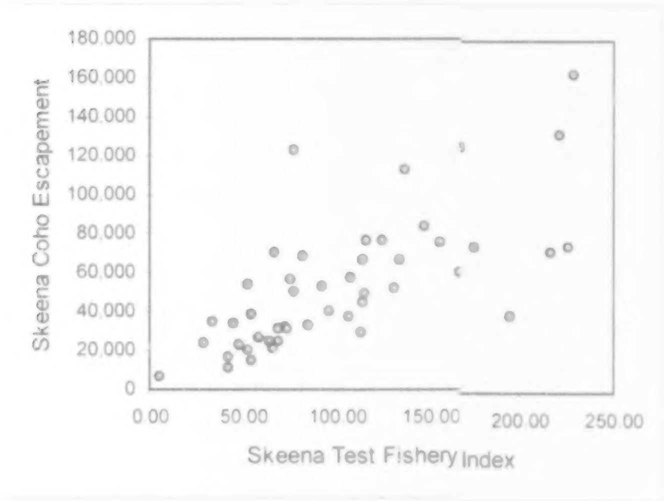


Figure 5.9. Relationship between the annual Skeena test fishery index for coho salmon and the total spawning esapement reported for the Skeena River (Area 4) in the same year.

While the relationship has variability in it, there is a clear indication of a linear relationship. In other words, when the index is very small, as it was in 1997, then the coho spawning escapement is expected to be very small, too. In Figure 5.9, the lowest test fishery index is clearly associated with the smallest coho spawning escapement observed since 1956.

The Skeena test fishery is an example of an important monitoring program that integrates the return of coho salmon to many streams. To generate the relationship presented in Figure 5.9, though, the annual spawning escapements to each coho stream have also been monitored. The test fishery provides some corroboration to the spawning surveys and, if calibrated, could even replace the need for annual surveys of every stream. The latter option is a question for Fisheries and Oceans Canada assessment staff and will not be discussed further by the PFRCC, but it does relate to the problem of annual monitoring of coho spawning escapements over a large region and in fall weather conditions.

The coverage of coho spawning escapements by stream in the northern BC is problematic. Of the 607 different streams with reported coho salmon escapements, only 12% of the streams have annual records for more than 40 years (about 8 in 10 years), and 37% have records in less than or equal to ten years. The remaining 51% of the streams are widely distributed between 11 to 40 years of records (Figure 5.10).

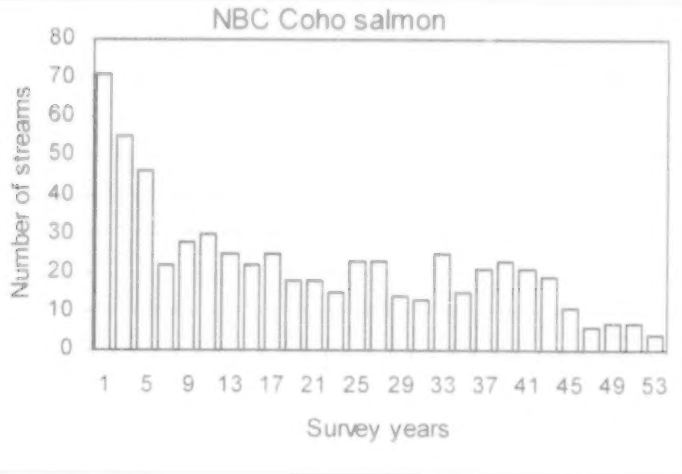


Figure 5.10. Distribution of the number of streams surveyed annually for coho salmon spawning escapements in northern BC.

Since 1950, there are 53 possible years of surveys. Each category on the horizontal axis contains two years (e.g., 1 includes streams surveyed 1 or 2 years since 1950).

The questionable validity of coho escapement surveys in difficult conditions is reason for caution about their use as a measure of coho salmon status. However in terms of broad regional trends, these data indicate a significant change in the distribution of spawners between streams (Figure 5.11).

In previous chapters of this report, we presented plots of the cumulative total number of spawners across streams after ranking the streams from largest to smallest within a time period. These plots typically curve upwards from the origin and then gradually flatten as the smaller populations add less and less to the cumulative total over all streams. For northern coho salmon, the diversity plot indicates a small shift to the left for the largest streams during 1991-2000, but the major change is the rapid flattening of the 1991-2000 curve. The shift to the left involves only a few streams and is likely attributable to coho enhancement programs. However, the flattening of the curve and the lower total value of the 1991-2000 curve suggests substantially smaller spawning escapements to most coho streams. Recall though that Table 5.3 indicates a recovery of coho abundance in recent years.

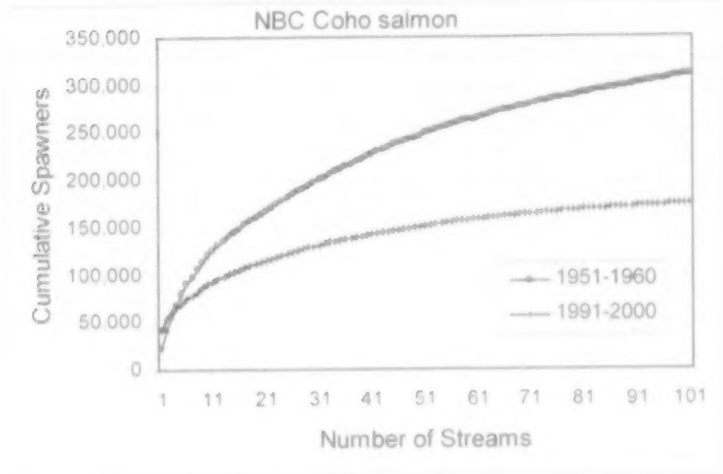


Figure 5.11. Cumulative total spawning escapement by stream for northern BC coho salmon.

Only the first 100 streams were plotted in this figure.

Unlike the results for central BC coho salmon, the change in this diversity plot is not readily explained by changes in the frequency of escapement surveys over time (Figure 5.12). The proportion of the northern streams surveyed over five times in a decade was initially smaller than in the central region, but the number of streams involved was substantially larger. The proportions of northern coho streams surveyed were quite consistent between the 1950s and 1990, and only showed a decrease in frequency of visits in the most recent decade.

Even during the 1991-2000 decade, 28% of the streams were surveyed in over half of the years (169 streams surveyed). This number of streams could represent an adequate sample of coho streams, but this would, again, depend upon the geographic range of the streams and whether or they are an unbiased indicator of coho escapement trends. Accuracy of measurement in this case remains another issue.

The distribution of streams monitored for escapement in each of the five northern BC sub-areas is presented in Figure 5.13. The pattern of survey frequency changed over time, and it was actually different from other species and areas considered in this report.

With the exception of surveys in the Queen Charlotte Islands sub-area, the proportion of streams with high survey frequency has been declining steadily over time especially in the North Coastal sub-area. In the recent decade, most of the surveys were conducted in the Kitimat, Queen Charlotte Islands, and Skeena River sub-areas. The reduction in the North Coastal sub-area reduces the representation of streams in Portland Inlet, the lower Skeena and outer islands, and all of statistical area 5 which would be a large portion of the coastal environments for coho salmon. This change should clearly be reviewed in any consideration of future stream surveys. Without assessing the consistency of surveys in these remaining streams (i.e., recently surveyed streams) and how representative the streams are of coho distribution and habitats, the PFRCC cannot comment on the adequacy of the current survey efforts.

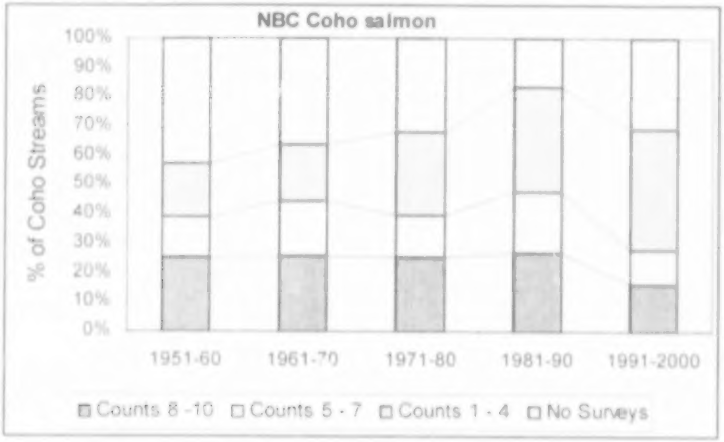


Figure 5.12. The percentage (%) of northern BC coho streams for that have been surveyed 8 to 10 times, 5 to 7 times, or 1 to 4 times in each decade, and the % of the 607 coho streams that were not surveyed in a decade.

Note that the specific streams surveyed vary over time but there are 607 streams accounted for in each of these decades

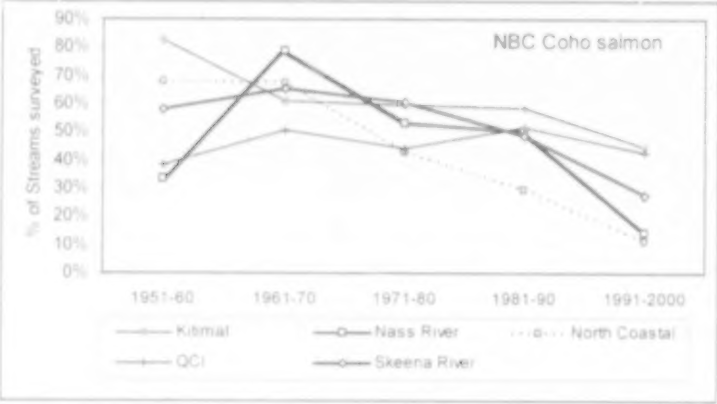


Figure 5.13. Changes in monitoring frequency by sub-areas and decades for northern BC coho salmon.

Plot is the percentage of all streams surveyed (i.e., any stream with an escapement record in a decade) with at least 6 surveys in a decade

5.4 Northern BC Coho Enhancement

Enhancement of coho salmon in the north involves two major hatcheries (Kitimat, Area 6 and Pallant Creek, Area 2E), plus several smaller facilities managed by community programs and First Nations (e.g., Kincolith, lower Nass River, Fort Babine, Masset, Hartley Bay, etc.). The release strategies are diverse including releases of fry coho in several months, 1+ smolts from the larger hatcheries, and sea-pen reared smolts from Pallant Creek. On the Queen Charlotte Islands, the majority of coho releases have been under-yearlings (fry) from numerous facilities. Recently, Pallant Creek facility significantly increased their release of sea-pen reared smolts (Figure 5.14). This figure presents releases by spawning year. The release year can be associated to the spawning year by adding one year for fry releases and two for smolt releases.

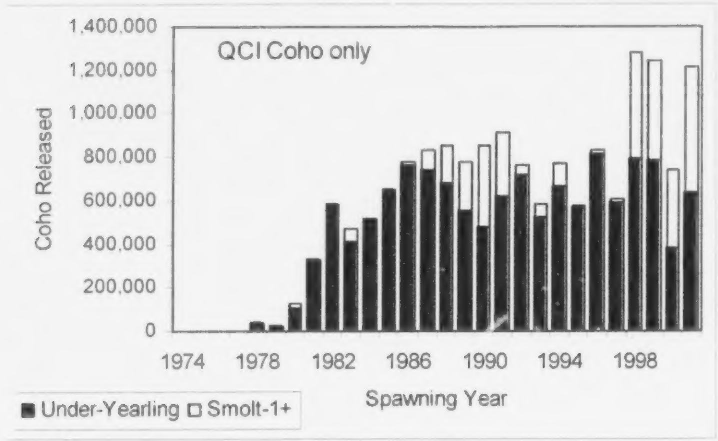


Figure 5.14. Releases of coho salmon from enhancement projects on the Queen Charlotte Islands. The major facility for this area is Pallant Creek Hatchery.

Releases from all other areas in northern BC are included in Figure 5.15. Releases in this figure include those from the Kitimat Hatchery, interior Skeena programs, and all those in the coastal areas of Area 3A and the Nass River, 4A, 5 and 6. In contrast with the releases from Queen Charlotte Islands programs, the majority of releases in these other areas have been smolts, including a large proportion from Kitimat Hatchery. The release of these larger coho provides opportunities for coded-wire tagging of coho. Their subsequent recovery from fishery catches (in Alaska and Canada) and in the spawning escapements allows for estimation of catch distribution of the stocks (see Table 5.2).

When the spawning escapement is sampled quantitatively, tagging also allows for estimation of marine survival rates and fishery harvests rates (i.e., the proportion of the total production from one spawning year from a population that was killed by fishing). As an example of the information gained from coded-wire tagging of coho salmon, Figure 5.16 presents the marine survival rate for four coho indicator stocks in northern BC. Survival rate is measured as the total number of tags recovered from fisheries and spawning coho divided by the total number of tagged coho released in a year and population. For some populations, such as Fort Babine in Babine Lake, upper Skeena River and Toboggan Creek in the mid-Skeena River, some mortality will occur during downstream migration. However, this downstream mortality has not been estimated and is included in estimates of total mortality (frequently referred to as marine mortality). The data available to estimate survival are the actual tags recovered. Estimates of total mortality is simply one minus the estimated survival rate (value from 0 to 1). The data used in these figures are available in Sawada et al. (2003).

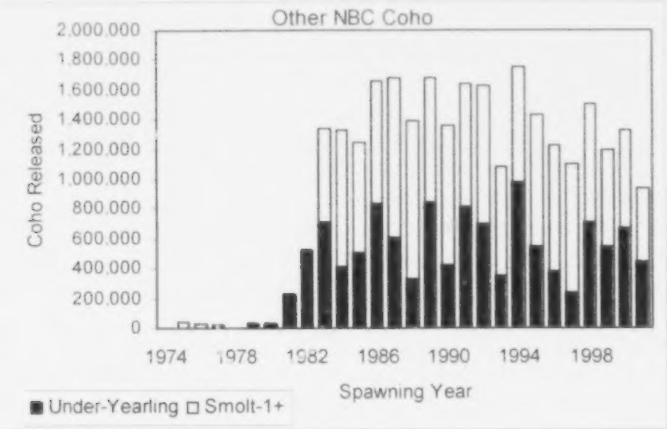


Figure 5.15. Releases of coho salmon from enhancement projects in northern BC, excluding those on QCI. The major facility for this area is Kitimat Hatchery.

The variability in annual survival rates and differences between populations are immediately obvious. Lachmach River has consistently had higher estimated survival rates, but the pattern of changes between years is very similar between populations. The poor return of Skeena coho in 1997 is observed in each indicator and, in particular for Fort Babine and Toboggan Creek. Returns in the Area 3 indicators (Lachmach and Zoulzap) declined in 1997 but not to the degree estimated in the Skeena indicators. After 1997, survival rates have increased in each indicator, but to a lesser degree in the upper Skeena indicator, Fort Babine.

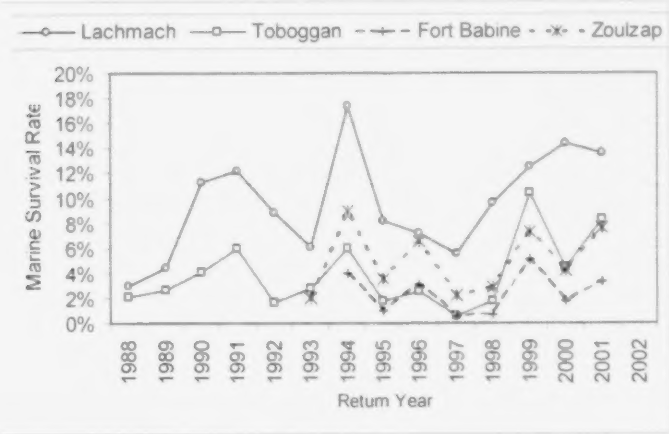


Figure 5.16. Estimated marine survival rate of tagged coho salmon released from four indicator stocks in the Skeena River (Toboggan Creek, Fort Babine), Lachmach River in Work Channel, and the Zoulzap River in the lower Nass River.

Survival rate is presented by Return Year for comparison with other graphs of escapement returns, and can be associated with the spawning year by subtracting three from the Return Year.

Marine survival has varied by about ten-fold during these years. Estimating this source of variation is important when a fisheries manager tries to assess returns to a population but does not know the cause of changes. For example, if coho returns are poor, did the natural survival decrease or did fishery impacts increase? With tagged indicator stocks, the cause of a change in spawning escapements can be assessed and management plans developed on the basis of actual information. **Given the difficulty of monitoring coho spawning escapements, limited confidence in results of visual monitoring, and the catch of coho in large mixed-stock fisheries (including in South-East Alaska); the coded-wire tagging of indicator stocks has been the fundamental basis of coho information used in management and research since the mid-1980s.**

5.5 Coho Salmon Summary

Coho salmon in the central region have been reported in essentially the same number of streams as chum salmon in the same area (137 steams plus 2 spawning channels), but with the later seasonal return of many coho populations this number is likely a conservative value. Essentially all the coho escapement data in the central region are based on visual survey methods and are acknowledged to be of limited value for coho assessment purposes. There are no indicator stocks for coho salmon in central BC but Fisheries and Oceans Canada is attempting to establish an indicator stock in the Martin River, near Ocean Falls. Based on the reported escapement data, trends in coho spawning escapements declined until the late 1990s, but have increased in recent years. Coho returns to the Bella Coola system account for the majority of coho salmon escapement in central BC.

The difficulty in conducting escapement surveys for coho salmon in the central region is clearly indicated in the frequency of survey coverage since 1950. Unlike pink and chum salmon surveys, the vast majority of coho streams in central BC have recorded escapements in less than half of the years (Figure 5.4). Only the Bella Coola River has been surveyed each year and the Martin River in 48 of the 53 years. Furthermore, the number of inspections of streams has not been as well maintained for central BC coho. Reduced survey frequency was continued into 2001 and 2002 and further reduced the degree of confidence in tracking trends in coho salmon status or spatial distributions.

Coho salmon in north BC are widely distributed and reported in over 600 streams. The trends in coho spawning escapements have been similar to the pattern in the central region. The poorest return recorded for northern coho occurred in the Skeena sub-area in 1997, and subsequently resulted in the closure of Canadian fisheries that impacted that stock. An index of coho returns to the Skeena River in 1997 was only 5% of the long-term average up to that year. As in central BC, key indicators of northern coho returns indicate improved coho salmon abundance in the most recent years:

- Increases were evident in the reported spawning escapements based on the visual surveys (but this information in confounded with a significant reduction in the number of streams surveyed).
- There were improved annual coho indices in the Skeena test fishery (Figure 5.8).
- Increased marine survival was estimated in four northern coho indicator stocks (Figure 5.16).

The coverage of coho spawning escapements by stream in northern BC is problematic. Of the 607 different streams with reported coho salmon escapements, only 12% of the streams have annual records for more than 40 years (about 8 in 10 years), and 37% have records in less than or equal to ten years. The distribution of survey effort between streams has been quite consistent until the past decade, but the distribution of spawning population sizes between streams suggests a significant reduction in the numbers of spawners in many of the coho streams. This latter trend is of particular concern since the reduced escapements have been occurring in spite of numerous enhancement programs.

Coho enhancement in northern and central BC involves three major hatcheries and many strategies using smaller-scale local programs. Coded-wire tagging of coho released from enhancement facilities has provided good information on the distribution of these coho populations in Alaskan and Canadian fisheries. However, in many cases, the total spawning return has not been quantitatively estimated or sampled for tag returns. Given the major changes in fishing impacts on these populations over time and the variability in marine survival, these data are essential for assessment of coho escapement trends. Quantitative programs for spawning escapements and tag recovery exist in four indicator stock programs in northern BC: Lachmach River, Zoulzap River, Fort Babine, and Tobaggon Creek. **It is notable though that there are no quantitative indicator stock programs for coho salmon on the Queen Charlotte Islands or in central BC.**

5.6 Council Discussion

The wide distribution of many coho populations and the difficulty of enumerating coho in these systems make assessment of coho in these regions a challenging task. However, where the escapement records could be compared with more quantitative methods, the trends seem to be consistent. With the continued reduction in the number of escapement surveys conducted for coho salmon, though, it is not evident whether or not this consistency is likely to continue. With fewer and fewer surveys being conducted, questions arise about the spatial distribution of surveys, how representative the monitored streams might be in terms of coho distribution and habitats, and how changes in survey methods have undermined comparability of data. **Furthermore, the Council strongly believes that indicator stocks for coho salmon are essential to provide data on changes in marine survival rates and fishery exploitation rates over time.** Survival rates have been shown to be highly variable and fisheries have changed substantially over the past decade. Indicator stocks provide the only reliable means currently available to assess the causes of changes in coho production and to provide verification for the visual escapement surveys. We note that presently there are no indicator stocks for coho salmon in Kitimat (Area 6), the Queen Charlotte Islands (Areas 1, 2E, 2W), or all of the central BC region (Areas 7-11). If Martin River (Area 8) continues to be developed and supported as an indicator stock, it could address the latter concern for central BC.

The Council's primary recommendation for coho salmon in central and northern British Columbia is the same as for the other species. There is an essential need to specify an assessment framework for coho that is consistent with the information requirements of effective resource management. Long-term commitments and budget resources are essential to establish a new assessment base that allows for comparability with the historical record. As discussed in the other species, the requirements for data will vary to some extent with the intensity of fisheries and/or local developments. For example, the coded-wire tag data from the northern indicator stocks have recently been developed into an in-season fishery management tool that could be used to limit ocean fishery impacts on these stocks (Cox et al. 2003). Or, if fisheries have high exploitation rates, then the information quality should be better to assess impacts of fisheries and explain trends in coho returns. The wide distribution of coho salmon presents a problem of providing data from fisheries that affect many populations together, while at the same time the data must fulfill needs for localized information for a community or watershed assessment. The framework will logically involve a balance among:

- intensive indicator stock programs (limited number of high quality quantitative data for assessment of marine survival and fishery impacts);
- extensive coverage of the natural habitats and spatial distribution of coho salmon (a sample of streams over the geographic range for more qualitative visual surveys); and,
- long-term commitment to a monitoring budget and co-operative programs with local interest groups.

The Council observed that coho returns in these areas seem to have improved in recent years, but we also noted the substantial decrease in stream survey coverage. A continuation of ad hoc reduction in surveys could increasingly compromise the ability of Fisheries and Oceans Canada to assess coho salmon in these regions and the basis for fishery management decisions. If budget reductions are extended to the indicator stocks, then their assessment and scientific capabilities will be greatly reduced. **An assessment framework is essential to be developed for this diverse resource. It should be designed to meet an agreed set of objectives and be supported by a long-term core funding commitment.**

In developing this assessment framework, Fisheries and Oceans Canada must also consider how central and northern BC coho salmon may be accounted for under the Canadian Species at Risk Act (www.speciesatrisk.gc.ca). The Act defines a wildlife species as :

> *"a species, subspecies, variety or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and (a) is native to Canada; or (b) has extended its range into Canada without human intervention and has been present in Canada for at least 50 years."*

The application of this definition to coho salmon is not likely to be easy. Coho are widely distributed and their "variety" and genetic differences are not well documented. If coho returns continue to improve and fisheries operate at conservative levels, then there is a temporal opportunity to begin collating this information before it is required. In developing the geographic range or extent of these coho groupings, Fisheries and Oceans Canada could incorporate information on biochemical genetic variation, ecological zones, and life history traits as recently presented by Waples et al. (2001) for salmonids in the U.S. Pacific northwest.

6.0 CHINOOK SALMON (*ONCORHYNCHUS TSHAWYTSCHA*)

Of the five species discussed in this report, chinook salmon are the least abundant and utilize the fewest streams for spawning and rearing. Chinook salmon are, however, the most diverse in life history variations among Pacific salmon in central and northern BC. An excellent description of life history variation in chinook salmon is provided by Healey (1991). Variation in adult migration timing is characteristic of this diversity. In central and northern BC, chinook may enter freshwater from mid-spring and through into the fall. The earliest, or spring chinook, are generally destined for upper portions of the large rivers (Skeena and Nass), while summer components are the most common run-type and return from mid-June through to mid-August. A few late-run or fall migrants also return to the coastal rivers. The most famous of these central and northern BC chinooks are the Kitsumkalum and Wannock River fish that are world renowned for their large body size and recreational fishing. Consequently, chinook salmon may be less abundant numerically in central and northern BC, but they are highly diverse as localized "races" or types of chinook.

6.1 Central British Columbia Chinook salmon

In the central BC region, chinook salmon have been recorded in only 30 different streams and populations that have averaged over 100 spawners are limited to only nine or less streams in a decade (Table 6.1). There are more spawning locations known, but those streams have been combined within watersheds, such as the tributaries to the Bella Coola River or into Owikeno Lake. Escapement records also identify nine other streams with periodic records of chinook salmon, but their status as annual spawning locations is uncertain. It is also notable in Table 6.1 that only nine streams with chinook spawning populations have been monitored in over half of the years since 1950.

As with most escapement surveys, the consistency of methods and ability to estimate the chinook returns in these systems are highly variable. For the streams in Table 6.1, the monitoring in the Bella Coola system (including the Atnarko River tributary) and the Dean River are considered to be the most reliable, but changes in methods over time complicate the interpretation of most other systems. Even in the Docee River and Wannock rivers, the difficulty in documenting survey methods over time has resulted in fisheries-related issues. The Docee River has been dropped as an escapement indicator in the Pacific Salmon Treaty discussions, and the Wannock River became an issue in 1999 when the reported return plummeted to only 500 chinook (McNicol 2000).

Table 6.1. Streams with chinook spawning records by decade in central BC.

This table includes the average recorded escapements by system, statistical area location, and the number of surveys conducted since 1950. Streams were ranked by number of surveys.

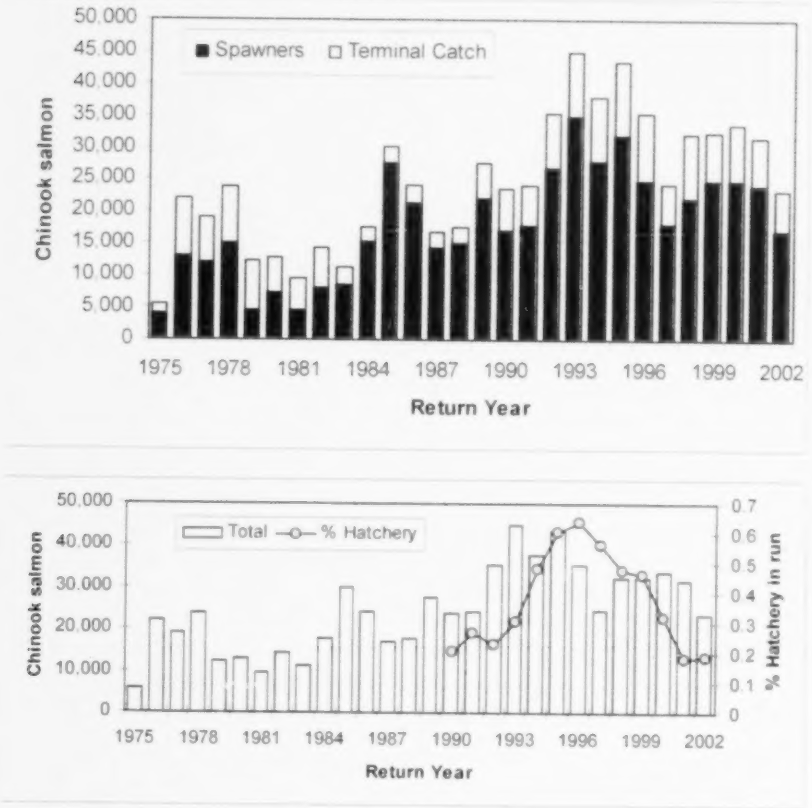
Stream Name	1951-60	1961-70	1971-80	1981-90	1991-00	2001-02	Stat. Area	Total surveys
Bella Coola River system	19,500	16,345	13,620	15,457	25,886	19,500	8	53
Docee River	1,880	435	1,040	765	560	300	10	52
Wannock River & Flats	2,406	2,875	2,050	2,955	6,150	2,900	9	51
Dean River	643	2,708	3,100	2,505	1,790	3,748	8	45
Chuckwalla River	75	223	148	188	312	650	9	44
Kilbella River	342	416	177	290	582	1,449	9	41
Kwatna River	0	817	370	48	35	*unknown*	8	34
Kimsquit River	1,750	750	208	175	163	*unknown*	8	30
Taleomey River	0		25	48	20	*unknown*	8	21
Nekite River		25	56	32	33	*unknown*	10	18
Noeick River	83		150	33	6	*unknown*	8	17
Clyak River		35	76	3	25	*unknown*	9	14
Elcho Creek	0		4			10	8	12
Owikeno Lake tributaries (n=8) combined	144	521	342	268	182	799		1 to 27

The chinook system that has had the most intensive chinook assessment in central BC is the Bella Coola River. These chinook have provided important fishing activity in the local area and is the site of a major chinook hatchery (Snootli Creek Hatchery). Releases and coded-wire tagging of chinook from this hatchery have occurred since 1982, providing a long record for hatchery assessments and management. However, to fully utilize these data, quantitative estimates of the spawning escapement and local harvest are needed. The hatchery and local management staff have put an extensive effort into developing the necessary estimation and recovery programs, but the Atnarko program has not yet been fully developed as an indicator chinook stock. Estimates of the annual chinook returns have been developed, but uncertainty due to differences between estimates within years has limited the reliability of the quantitative tag recovery estimates. Assessments of central BC chinook escapement trends are largely based on the reported escapements to the Bella Coola River system, Dean River, Wannock River, and more recently to the Chuckwalla and Kilbella rivers. The latter rivers were included due to concerns during the 1990s about their conservation and directed enhancement programs for them through a local community program. Each of these chinook escapement estimates is accepted as being an index of the true values.

The estimated total return to the Bella Coola River system, including terminal catches and spawning escapement, has consistently exceeded 20,000 chinook since the mid-1980s (terminal catches plus spawners presented in Figure 6.1).

Figure 6.1. Total estimated return of chinook salmon to the Bella Coola River system (including the Atnarko River) since 1975.

The top figure presents the total return to the system and the "best estimate" of the proportion from hatchery production (estimated since 1990) is superimposed on the total return in the lower figure.



The smooth form of the hatchery contribution curve in Figure 6.1 (% Hatchery) is likely explained by variation in survival rates between spawning years and the over-lapping of return years in chinook (over ages 3 to 5 years). However, the significant decline in hatchery contribution in recent years is not as easily explained. The number of smolts released from Snootli Hatchery into the Bella Coola system has been very consistent since the mid-1980s, with the exception of the 1998 brood year (1999 releases) when releases were about half of the previous level. Survival of the hatchery fish was apparently declining while the total return (hatchery plus wild) was more consistent.

The other important escapement indicator stock is the Dean River (Area 8). These returns are used by the Canadian section of the Chinook Technical Committee as the indicator for returns of "wild" chinook salmon in central BC (Figure 6.2). The Dean valley or corridor is a protected area in British Columbia and is recognized as an important area for the conservation of ecological and wildlife conditions. The river is famous for its steelhead fishing and also has a significant chinook salmon return. In Figure 6.2, the escapement values for 2001 and 2002 are separated from the previous data because Fisheries and Oceans Canada is developing a more quantitative method for estimation of these spawning escapements. Frequently, the introduction of more accurate methods for estimation results in an increase in the reported escapements and the new method introduces an inconsistency with previous records. Comparisons over time will allow for adjustment of past data to provide a more consistent series of observations.

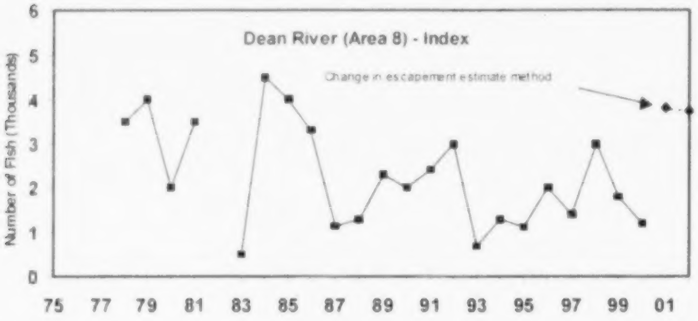


Figure 6.2. Reproduction of the Dean River chinook escapement index from the Chinook Technical Committee of the Pacific Salmon Commission (CTC 2003). *The horizontal axis is return years since 1975, and vertical axis estimated chinook spawners.*

Returns to the Dean River varied between one and three thousand chinook since the late-1980s, but have shown a significant increase in recent years. As noted above, these estimates of returns are confounded with a change in methods. Field staff, though, reported that recent returns had definitely increased relative to past years.

In Rivers Inlet (Area 9), the Chinook Technical Committee uses an escapement index composed of the Wannock, and Chuckwalla-Kilbella rivers. Chinook in these two systems have different run timings and juvenile life histories (see Table 6.2 below), and likely have different survival patterns. Consequently, Canadian members of that Committee recently separated the rivers into two escapement indices (Figure 6.3a and b).

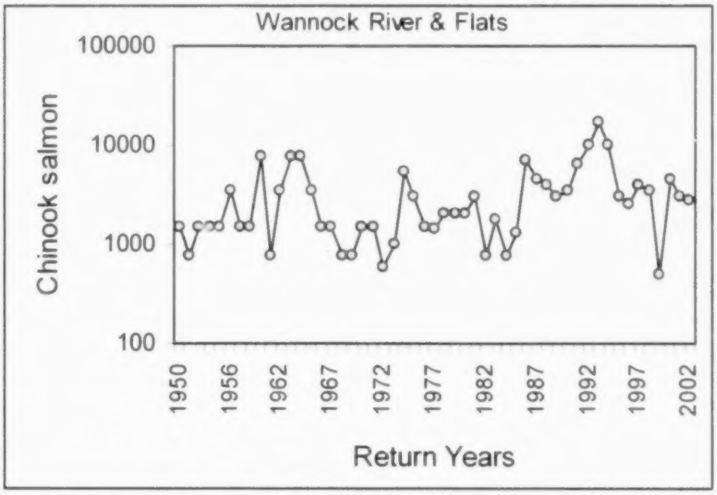


Figure 6.3a. Chinook spawning escapement estimates to the Wannock River and outer flats, 1950-2002.

Variation in numbers of spawners is from 500 chinook in 1997 to 17,000 chinook in 1993. The median observation since 1950 is only 2,000 chinook, but after the 1985 Pacific Salmon Treaty the median doubled in value.

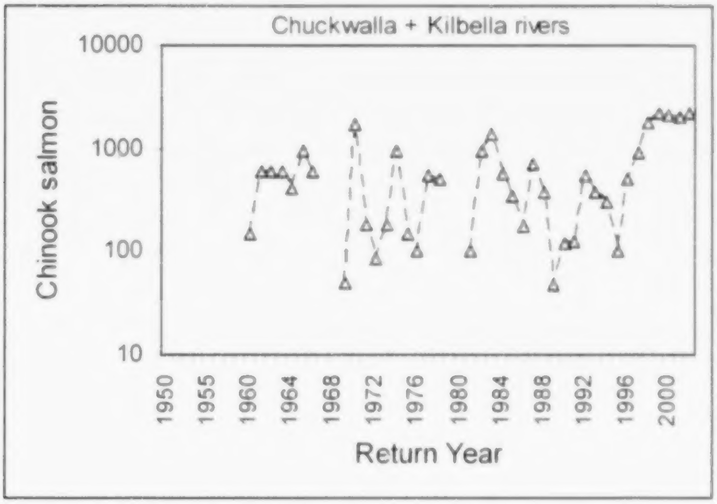


Figure 6.3b. Chinook spawning escapement estimates to the Chuckwalla and Kilbella rivers, 1960-2002.

Data for 1950s are very limited

Between 1960 and 1996, the combined escapement had been small and in several years only about 100 spawners. However, in the past 5-6 years, spawning escapements have increased to over 2,000 chinook per year. Enhancement releases have contributed to these increased returns (see Table 6.2 below).

Other than the chinook streams identified in Table 6.1, there are only nine streams with very small numbers of chinook (< 25 spawners recorded) and/or very few observations. Five of these streams are in Area 7 near the Fiordland Recreational Area (upper Mathieson Channel) and two are in Area 11 (Seymour River and Waump Creek). Over the 30 different streams with reported chinook escapements in the central region, 21 have been surveyed less than half of the time (Figure 6.4).

As noted in the introduction, the number of streams with chinook salmon spawners does not indicate a diverse resource base. However, each of these larger populations has biological traits and/or habitats that differentiate them from each other, and increase the importance of between population diversity. These differences are best known for the populations that have fishery values (or conflicts), but may be presumed to also extend to other populations, particularly those in different environments. Table 6.2 summarizes the biological traits and habitats for the major populations shown in Table 6.1. Table 6.2 is not intended to be a comprehensive listing of differences, but to serve as an example of the range of differences among these few chinook populations.

Table 6.2. Summary description of habitat, life history, and enhancement differences for major chinook populations in central BC.

Population	Stat. Area	Habitat	Juvenile traits	Adult traits	Enhancement	Other comments
Docee River	A10, Smith Inlet	Very short river (0.8 km) at outlet of Long Lake, spawning limited to about 0.5 km.	Under-yearling, Ocean migrant	August return to terminal area, spawning in mid to late October	One record in 1975, no other records for Chinook	Enumeration conditions difficult, numbers of spawners likely between a few hundred to a couple of thousand
Wannock River	A9, top of Rivers Inlet	Outlet of Owikeno Lake, 6 km river, lake is glacial and river is wide and usually turbid	Under-yearling, Ocean migrant	Late July through August return to terminal area, spawning from mid October to mid November	Fed-fry and net-pen smolts since 1983. Enhanced portion of return small (2-7%).	Adults are amongst largest Chinook in North America. Adults are 4 to 5 years old. Enhanced releases are tagged for monitoring.
Chuckwalla & Kilbella rivers	A9, north shore Rivers Inlet	Rivers join about 2 km from estuary, both rivers glacially influenced, no major lakes in system	Stream-type juveniles (1+ migrants), but enhanced fish are under-yearlings	Late June through July return timing, spawning from mid-August through September.	Fed-fry releases since 1987. Up to 50% of returns have been enhanced fish.	Adult fish are smaller than Wannock Chinook. Enhanced releases are coded-wire tagged for monitoring.
Owikeno Lake tributaries (information is very limited)	A9, top of Rivers Inlet	8 tributary streams, habitats variable from glacial to clear water	Very limited data, likely Stream-type migrants	Overall, timing is likely similar to Chuckwalla & Kilbella systems	Very limited and periodic. None in most tributaries	Numbers of spawners considered small, reported from tens of fish to a few hundred.
Bella Coola & Atnarko rivers	A8, at Bella Coola	Highly diverse from glacial rivers in Bella Coola to clear water and lakes in upper Atnarko River.	Mixed ocean and stream migrants depending on habitats. Atnarko mostly Ocean-type.	Late spring to early summer returns. Spawning variable. Atnarko from late Aug through Sept.	Extensive from Snootli Creek Hatchery, with extensive coded-wire tagging	Largest complex of Chinook salmon in CBC. Enhanced portion of run can be large.
Dean River A8, upper Dean Channel		Large river valley, diverse habitats with headwater lakes, largely clear water	Recent sampling indicates mostly Stream-type with some Ocean migrants.	Return to lower river in early July, spawning mid-Aug. to mid-September	None	Mixed red-fleshed and White Chinook. Highly valued Chinook and Steelhead habitats and in-river fishery.

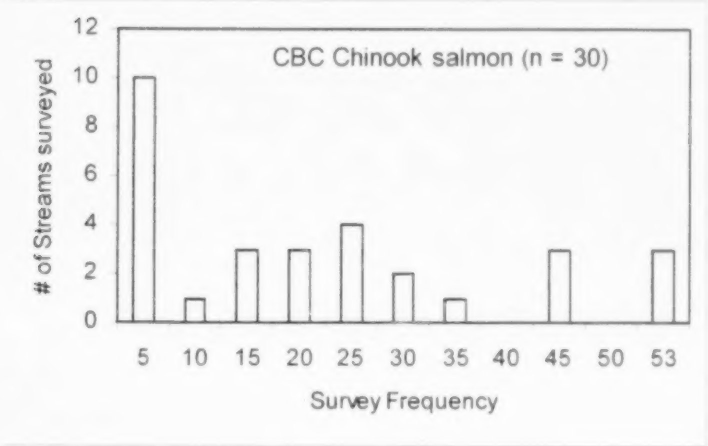


Figure 6.4. Number of chinook streams in central BC that have been surveyed during the 53 year period, 1950-2002.

Categories for Survey Frequency are grouped by 5's. For example, category 10 Survey Frequency includes steams surveyed between 6 and 10 times.

6.2 Chinook Enhancement in Central BC

Apart from small releases of fed-fry into the lower Atnarko River during the mid-1970s, the major increase in hatchery releases of chinook salmon occurred in the mid-1980s in the Bella Coola system (Snootli Creek Hachery, Figure 6.5) and in Rivers Inlet (Area 9, Figure 6.6). Early releases of chinook from Snootli Creek were fed-fry. But, once the capacity to rear smolts was developed, the release strategy quickly changed to smolts released into the Atnarko River and up to four other tributaries of the lower Bella Coola River. Since 1987, the number of released smolts has been quite consistent at about two million per year (Figure 6.5).

In Rivers Inlet (Area 9), enhancement programs have involved the Wannock River and the Chuckwalla–Kilbella rivers. One early release of fed-fry to the Docee River was noted in the records, but no subsequent releases are known. Chinook releases to the Wannock River have been fed-fry or smolts, mostly reared at the Snootli Creek Hatchery. Releases to the Chuckwalla and Kilbella rivers though have included fed-fry, smolts, and sea-pen reared smolts. These releases have largely been managed through the Shotbolt Bay Hatchery and managed by a co-operative program with the Rivers Inlet/Hakai Pass Sport Fishing Association. The number released into the Rivers Inlet area is less than into the Bella Coola River system, but their contribution to spawning escapements in the Chuckwalla and Kilbella rivers has been substantial in some recent years (up to 50%, Table 6.2. In the Wannock River, however, the proportion of chinook returns attributed to the hatchery releases has been much smaller (between 2-7%, Table 62.

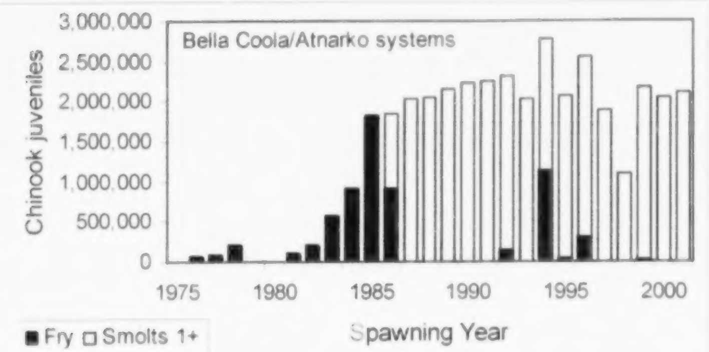


Figure 6.5. Releases of chinook salmon in the Bella Coola River system including the Atnarko River.

Releases are presented by Spawning Year, 1975-2001, but essentially all of these chinooks are released in the late spring to early summer of the next year.

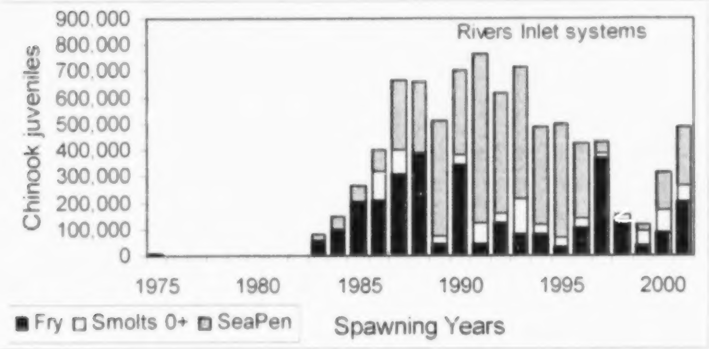


Figure 6.6. Total release of chinook salmon in the Rivers Inlet area.

Releases are presented by Spawning Year, 1975-2001, but all of these releases occur in the late spring to early summer of the next year.

Coded-wire tagging of chinook salmon has provided extensive information on the distribution and run timing of stocks released from hatcheries. The tagging also provides an important check on the age of chinook in catches and the mature chinook returning to the natal streams or facilities. The most informative use of this tagging data, though, requires quantitative estimation of the spawning escapement and tag recoveries. For chinook salmon in northern and central British Columbia, however, the only indicator stock program with adequate sampling of the spawning escapement is the Kitsukalum River program in the lower Skeena River. In the central region, tagging programs still provide useful information on catch distributions, size and age when caught, and run timing of chinook populations. Table 6.3 summarizes the catch distribution (over all ages) for three major hatchery stocks in northern and central BC.

6.3 Northern British Columbia Chinook Salmon

Chinook salmon in north BC are more abundant and diverse than in the central region. They have been reported spawning in about 105 streams since 1950 and infrequently in a few others (Table 6.4). In assessing escapement records, streams with one or two observations or average populations sizes of less than 25 chinook were omitted from the total counts. If the number of chinook spawning in a stream declined through time to 25 fish, or even less, then this stream remained in the analysis. Like the central BC chinook, the larger (i.e., in numbers of fish) northern BC chinook populations utilize larger rivers and tributaries, and there is a strong association with the outlet of large lakes.

Table 6.3. Catch distribution (% of total recoveries) of chinook salmon hatchery stocks tagged in central and northern BC.

Three time periods of recoveries are: Pre-1985 is previous to the Pacific Salmon Treaty (PST), 1985-1995 under the PST but previous to major closures in Canadian fisheries, and 1996-2000 is the most current 5 years with closures. The chinook stocks are: Snootli Ck Hatchery Atnarko chinook (SNO), Kitimat Hatchery Kitimat summer chinook (KIT), and Kitsumkalum summer chinook (KAL).

Fishery locations and gears	**Pre-1985**		**1985-1995**			**1996-2000**
	SNO	**KIT**	**SNO**	**KIT**	**KAL**	**KAL**
SE Alaska, fall and winter troll	6.1	11.8	11.4	21.3	5.0	12.0
SE Alaska, Inside waters troll	1.6	9.4	4.0	11.2	3.2	2.2
SE Alaska, Outside summer troll	27.3	10.2	10.6	9.9	26.0	19.8
Northern BC (Areas 1 to 5) troll	12.8	12.3	7.3	5.1	18.4	0.2
Central BC (Areas 6 to 11) troll	10.2	5.4	5.9	1.0	0.2	0.0
SE Alaskan Nets (all locations)	1.2	2.2	1.4	3.5	0.9	0.1
Northern BC Nets (seine and gillnet)	1.5	5.0	0.7	3.9	26.9	21.8
Central BC Nets (seine and gillnet)	23.9	10.4	41.0	4.4	0.4	0.0
SE Alaskan sport	1.3	6.6	1.2	7.2	6.1	21.5
North and Central BC marine sport	1.4	25.6	5.1	14.9	7.4	13.8
Terminal Area sport (freshwater)	1.2	0.0	10.6	17.2	5.4	8.4
* Other ocean Troll	2.2	0.2	0.6	0.1	0.1	0.0
* Other ocean Nets	5.5	0.1	0.1	0.0	0.0	0.0
* Other marine Sport	3.8	0.8	0.0	0.3	0.0	0.2
Total	100%	100%	100%	100%	100%	100%

** "Other" includes many fisheries along the coast that have small numbers of tag recoveries. For example, Snootli chinook are recoveried in the Johnstone Strait net and sport fisheries, and the troll fisheries in upper Johnstone Strait and along the west coast of Vancouver Island.*

Table 6.4. Average numbers of chinook salmon spawning within decades in northern BC.

This table includes the average recorded escapements by geographic sub-areas (top), and the average number of stream surveyed by sub-area since 1950 (lower table).

Sub-Area	1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2002
Kitimat	16,850	10,803	23,639	10,190	16,621	20,817	*439**
Nass River	200	13,341	19,972	9,505	9,719	15,911	14,967
North Coast	3,175	8,725	12,032	5,391	4,283	2,162	2,785
QCI		1,600	4,478	800	1,405	2,370	3,500
Skeena River	49,250	47,804	20,733	23,197	45,202	57,175	65,543
NBC Total	69,475	82,274	80,854	49,083	77,230	98,435	87,234

Sub-Area	1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2002
Kitimat	9	12	14	15	16	14	7
Nass River	1	5	9	14	13	15	3
North Coast	6	11	14	15	15	10	6
QCI	1	1	1	1	1	1	1
Skeena River	9	20	38	41	43	46	28
NBC Total	26	49	76	86	88	86	45

** **NOTE**: There have not been any spawning escapement surveys in the inside Kitimat region during 2000 to 2002, and there are no escapements recorded in several rivers.*

In assessing trends in chinook salmon spawning abundance, three major factors have been particularly influential:

- Fishing impacts: The decline in escapement through the 1970s largely reflected a combination of fishing pressures in Southeast Alaska, northern BC marine waters, and terminal areas. These declining escapements were a primary factor in establishing a coast-wide program in the 1985 Pacific Salmon Treaty to increase spawning escapements of chinook salmon. This program began in 1985 and reduced ocean fishing so that more chinook could reach their spawning streams. The immediate benefit of the Treaty for Skeena River chinook is evident in the rapid increase in the Skeena test fishery index from 1984 to 1986 (Figure 6.7).
- Hatcheries: The second factor was the major expansion of enhancement programs since the early 1980s. Returns of salmon increased through the 1980s and have been mixed with returns from natural production throughout the 1990s.
- Ocean impacts: The third factor has been variation in marine survival rates for chinook salmon. In the recent years, marine survival rates have improved in the key indicator stock in the north (Kitsumkalum River, Skeena River) and has been observed in the annual index for chinook salmon in the Skeena River test fishery (Figure 6.7).

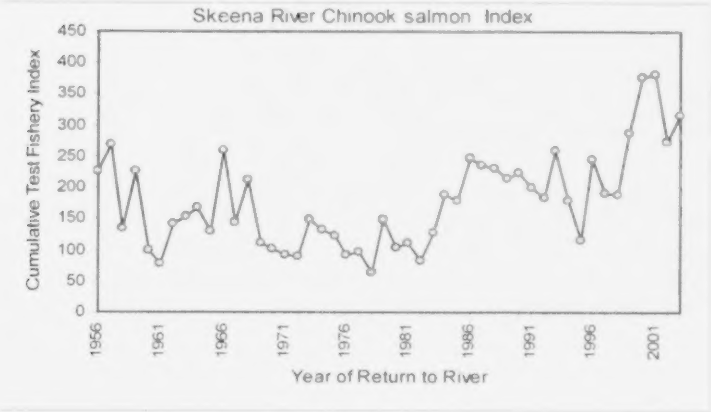


Figure 6.7. Cumulative annual index of chinook salmon returns to the Skeena River as monitored in the Skeena River test fishery at Tyee, BC, 1956-2003.

The monitoring of spawning escapements for chinook salmon in the northern BC region involves an array of programs and activities. These vary from the typical visual surveys to one indicator stock that has been monitored quantitatively since 1984 (Kitsumkalum River program, McNicol 1999), to counts of chinook salmon that pass through the Babine River fence, and periodic mark-recapture or fence programs conducted when funding was available. The intensity and methods for visual surveys also vary over time and sub-areas, particularly where enhancement programs have been established. Very recently, a number of First Nations have become increasingly involved in programs to improve escapement monitoring. Unfortunately, as federal government funding has declined in recent years, the monitoring of spawning escapements has been significantly reduced in some areas. Of most notable concern is the absence of chinook escapement data in Kitimat Arm (inner Area 6) after 1999. In the other northern sub-areas the surveys have been maintained or, in the case of the Nass River, the method has changed completely.

On the Queen Charlotte Islands, the Yakoun River is the only significant chinook-producing system. Chinook spawn primarily at the outlet of Yakoun Lake and are a summer-run stock. Visual estimates of escapement are made by foot surveys of the system and several attempts have been made to calibrate the surveys using mark-recapture studies. The visual estimates are expanded to an estimate of total spawning escapement in the system. Efforts are made to maintain consistency in the methods between years, but the accuracy (i.e. total escapement) of the annual returns is unknown. Returns to the Yakoun River have been increasing since the mid-1980s (Figure 6.8).

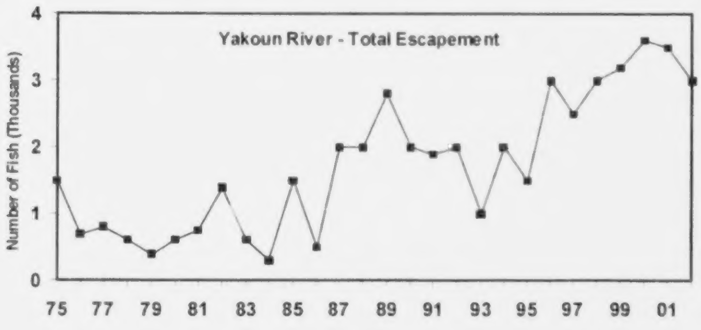


Figure 6.8. Estimated return of chinook salmon to the Yakoun River, QCI since 1975. Graph is reproduced from the Chinook Technical Committee report (CTC 2003).

The Kitimat sub-area has 14 chinook rivers (+2 infrequently surveyed) and it contains the only major chinook hatchery in northern BC. Development of the Kitimat Hatchery began in the late 1970s. By 1985 the facility was releasing over a million smolts per year. Chinook are released into the upper and lower Kitimat River, but are also distributed to the Dala River and Kildala River in Kitimat Arm, and Hirsch Creek, a tributary to the lower Kitimat River. The sub-area also supports purely natural chinook runs such as those to the Kitlope River at the head of Gardner Channel. This river in the Kitlope Heritage Conservancy Lands supports all species of Pacific salmon and steelhead trout. Recent assessments in this sub-area though are limited by essential no escapement surveys after 1999. However, between 1980 and 1999 a clear difference in annual chinook returns between the Kitimat and Kitlope rivers was evident (Figure 6.9). **The increase in Kitimat returns is clearly related to the major release of smolts into that river system, but the decline of chinook abundance in a natural habitat, such as the Kitlope River, is a cause for concern.** A sport fishery in Douglas Channel and Kitimat Arm developed in response to the hatchery production; there is no directed fishing on the Kitlope chinook, although they could be caught incidentally on their return migration. The timing of the change in returns is suggestive of a link with the Kitimat Hatchery production, but there is no direct evidence to support this supposition.

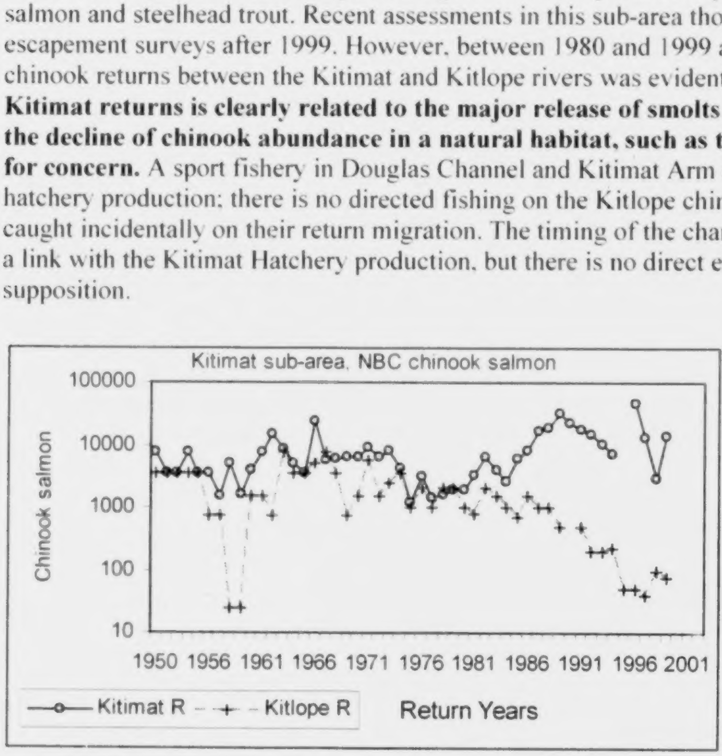


Figure 6.9. Chinook salmon spawning escapements recorded to the Kitimat River and the Kitlope River in the Kitimat sub-area (Area 6) of NBC (no data for returns after 1999).

Chinook returns to the North Coastal sub-area (outer portions of Skeena and Nass River areas, Portland Inlet, and coastal islands in Area 5) are also limited to about 14 streams. The Ecstall River (and Johnston Creek tributary) is the largest chinook system in the sub-area, but both indicate significant declines in escapement over time (Figure 6.10). Unfortunately, since 1990 these steams have only been assessed half of the time and their current status is uncertain. Similarly, chinook returns to two of the larger systems in Portland Inlet (Kwinamass River or Ksi X'Anmas, and Khutzeymateen River) have shown similar and long-term declines from the mid-1960s until the mid-1990s (Figure 6.11). Escapements in these systems have increased in recent years, but there are still only a few hundred to several hundred spawners. An attempt was made recently to improve the monitoring in these systems, but fishery managers continue to be uncertain about the cause of the decreased returns. All of these North Coastal chinook salmon are likely vulnerable to fisheries throughout northern BC. They could be harvested in troll and sport fisheries and the migration timing of the adults in mid to late summer would make them vulnerable to by-catch in net fisheries for sockeye and pink salmon (as demonstrated by the Kitsumkalum indicator stock in Table 6.3). If fishery impacts are a contributing factor, these populations should be receiving a measure of protection by recent reductions in ocean fishing.

However, impacts in terminal areas (i.e., those close to the natal stream) will be population-specific and require local assessments.

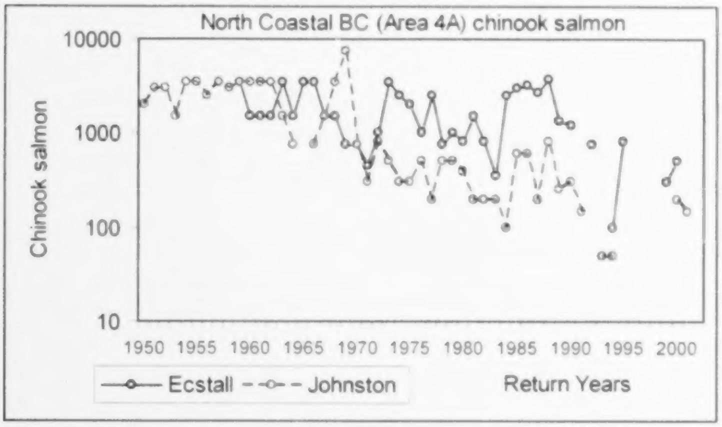


Figure 6.10. Spawning escapement to the Ecstall River and Johnston Creek in the lower Skeena River, 1950-2002.

Since 1990 annual escapements have been monitored half of the time in each system.

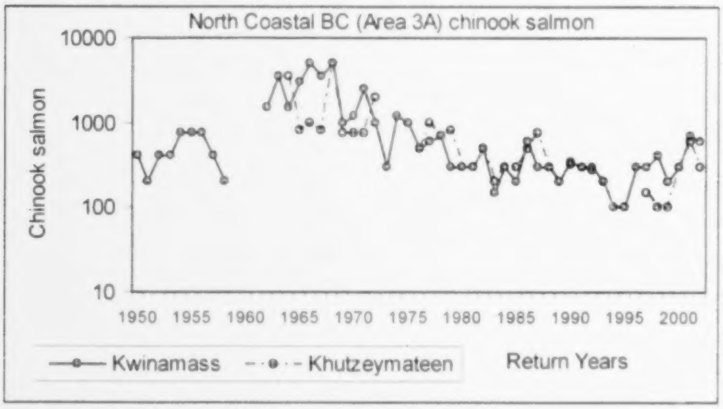


Figure 6.11. Spawning escapement trend to the Kwinamass River (Ksi X'Anmas) and Khutzeymateen River in Portland Inlet, Area 3A.

Long-term community enhancement programs have been conducted in the Kincolith River (Area 3A) and Kloiya River (Area 4A). Based on the recorded escapements, however, the increased escapement that would be expected due to enhancement has not been reported, except very recently in the Kincolith River. The basis of that increase should be further examined; the extent of the increase is similar in scale to that observed in the Kwinamass and Khutzrymateen rivers, and a counting fence has been used to enumerate chinook in the Kincolith River since 2001.

The major sources of chinook in northern BC, in both numbers produced and diversity of spawning populations, are the Nass and Skeena rivers. In our definition of the spatial areas for the northern region, the Nass River below Greenville (defined in escapement records as Area 3A) is included with the North Coastal sub-area. In this discussion of the interior Nass River (Area 3B), about 13 chinook spawning streams (up-stream of Greenville) plus the Nass mainstem are the centre for chinook production and extend over diverse habitats and a large geographical area. Prior to 1992, the estimates of escapement were based on visual counts that varied considerably between streams and years. Those estimates were based on stream walks and aerial surveys, and the frequency of surveys depended on funding, staff availability and weather.

Since 1992, the Nisga'a Tribal Council has conducted mark-recapture programs to estimate the total spawning escapement in the interior Nass River. Local DFO guardians also conducted independent visual surveys of escapement on the Nass River tributaries in 1992 and 1993, but these were discontinued in 1994 (outer Area 3A rivers continue to be estimated using visual surveys). The mark-recapture program uses two fish wheels in the lower Nass canyon to apply tags and two wheels in the upper canyon for recovery. Tags are also recovered in up-river fisheries and on the spawning grounds. A mark-recapture study conducted in this way provides an estimate of the total return of chinook salmon passing the point of tagging (i.e., all tributaries up-stream of the canyon). Reports of each year's program are available, for example, Link and Nass (1999).

Because of these major changes in escapement methodology, the Nisga'a Tribal Council and Fisheries and Oceans Canada agreed to standardize an escapement time series since 1975. The standardized escapements were developed using the two years (1992-1993) of Fisheries and Oceans Canada observations and the mark-recapture estimates for those two years. The difference between the two methods was used to develop a "scaling factor" for the historic visual estimates. Estimates of the terminal run of chinook to the Nass River were similarly derived. These methods and data used are documented in the Fisheries Operational Guidelines (FOG, March 9, 2000, Tribal Office, New Aiyansh, BC) that was prepared for the Nisga'a Tripartite Comprehensive Claims Negotiation. It is these revised estimates that are presented for escapement and terminal run in this report (Figure 6.12). In Figure 6.12, the plots are broken between 1991 and 1992 to indicate that the new programs began in 1992 and the previous data points are extrapolated from recorded observations multiplied by 2.55, the "scaling factor". A smoothed trend line is included in Figure 6.12 since a constant scalar is very unlikely to apply equally in all years. For example, the large value of 46,000 total return in 1986 could result from a strong escapement in that year, but possibly the survey conditions were also good. The scalar may then over-estimate the actual return. These types of uncertainties are always present with constant factors and can be accommodated by averaging a series of years. The trend line in Figure 6.12 is based on a 3-point average (the year of the data point ± one year) to allow for the age structure of chinook salmon. Since the mid-1980s, the return of chinook salmon to the Nass River has averaged about 25,000 fish. Total production of Nass chinook would be greater since the terminal run to the Nass River occurs after ocean fishery impacts in Southeast Alaska and British Columbia.

The largest group of chinook salmon in the north occurs in the Skeena River. In aggregate, these are the most abundant chinook and diverse populations in run timing and distribution throughout the drainage. The chinook populations considered in this interior Skeena sub-area include all populations up-stream of the Khyex River (Sub-areas 4B, 4C, and 4D). About 40 chinook streams are consistently surveyed in this sub-area and there are multiple spawning locations within some of these rivers. Only three spawning populations (Kitsumkalum, Morice, and Bear rivers) actually account for about 75% (range 62-86%) of the total Skeena spawner abundance (Figure 6.13). Escapement estimates are generally based on visual surveys from helicopter, fixed wing aircraft and/or from stream-walking surveys, except for a partial count of chinook past the Babine River fence (some chinook spawn downstream of the fence) and the Kitsumkalum program. The Kitsumkalum River is the exploitation rate indicator stock for northern BC chinook. Escapements have been estimated using an adult tagging program since 1984.

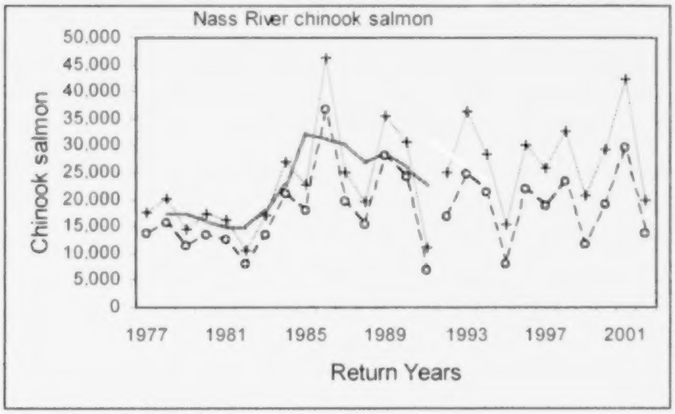


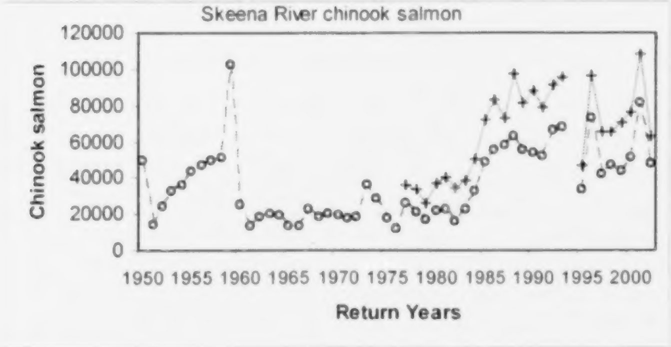
Figure 6.12. Time trend in chinook salmon return to the Nass River, 1977-2002.

Estimated numbers of spawnings (circles) and in-river catches are summed to determine the total return to river (+). The smoothed trend line, 1977 to 1992, is a 3-point moving average of total return to river before the Nisga'a Tribal Council program began.

Total escapements to the Skeena sub-area show three distinct periods of returns in Figure 6.13. The early period from 1950-1959 shows unusually consistent increases in escapements followed by the exceptionally high return to 65,000 chinook to the Bear River (verified in the written records). This was followed by a long period of modest but stable escapements between 1960 and 1984 (escapements of about 20,000, ranging up to 40,000 infrequently). Then after 1984, and with the establishment of the Pacific Salmon Treaty, the escapements increased significantly, now ranging between 40,000 and 80,000 chinook annually.

It is important to recall that these numbers are indices of changes over time and are not necessarily true numbers of chinook spawning, except where the fish are counted or estimated. Furthermore, not all spawning populations within the Skeena sub-area have followed the same trends. The most notable difference between populations is the return of chinook during spring and early summer (before July) versus summer chinook. The former populations are typically headwater populations (Bear and Morice rivers) but also include some lower river populations such as the Cedar River in the upper Kitsumkalum watershed. The latter populations (summer runs) return to the mid-Skeena areas and are more likely to be caught incidentally during sockeye and pink net fisheries, and in summer troll and sport fisheries (e.g., Babine and Kitsumkalum chinooks).

Figure 6.13. Time trend in chinook salmon return to the Skeena River (up-stream of the Khyex River), 1950-2002.



Estimated numbers of spawners (circles) and in-river catches are summed to determine the total return to river (+, total returns have only been presented since 1977). The anomalously large escapement in 1959 is solely due to a recorded escapement of 65,000 chinook in the Bear River, and the data point for 1994 is omitted because returns to the Bear and Morice rivers were not determined in that year.

The earlier spring-timed chinook show increasing trends since the late 1970s and then more stable escapements following the mid-1980s (Figure 6.14). However, the Babine returns (counts at the fence and visual estimates for chinook below the fence) do not show any notable improvement until the mid-1990s when significant closures occurred in Canadian fisheries for coho conservation (Babine returns are also numerically smaller, Fig. 6.14). Returns of the Kitsumkalum summer chinook are presented separately because there is more information on that stock due to indicator stock program (since 1984) and coded-wire tagging (Figure 6.15).

Spawning escapement of the Kitsumkalum summer chinook increased significantly in the late 1980s, but the increase was not co-incident with the 1985 Pacific Salmon Treaty. Based on the recovery of coded-wire tags from this indicator stock, it is likely that the increase was associated with good marine survival of juvenile emigrants during the early 1980s (1981-1983 spawning years, Figure 6.16).

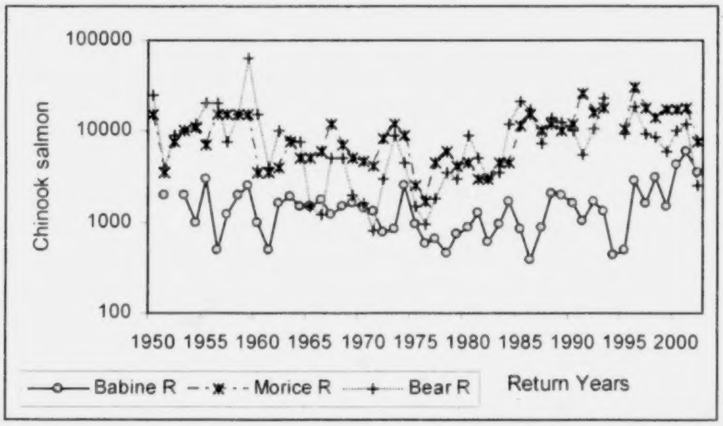


Figure 6.14. Time trend in chinook salmon escapements to three tributary chinook populations, 1950-2002.

Babine River Chinooks (circles) are a summer-timed adult return. The Morice (asterisk) and Bear (crosses) rivers are spring-timed chinook.

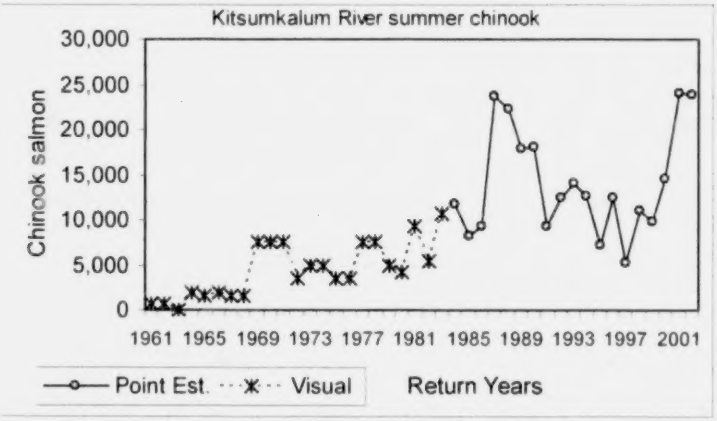


Figure 6.15. Time trend in chinook salmon escapements to the Kitsumkalum River summer chinook stock.

Escapement surveys using visual methods (1961 - 1983) and then mark-recapture programs ('Point Est.' or estimated value for 1984-2002).

Variation in marine survival rates is also likely to account for the decreased spawning escapements during most of the 1990s, and then the significantly increased returns in 2001 and 2002. To associate chinook returns to spawning year in the Kitsumkalum stock, the total age of returning male chinook is 4 to 6 years and for female chinook from 5 to 7 years (majority are 6 year, see McNicol 1999).

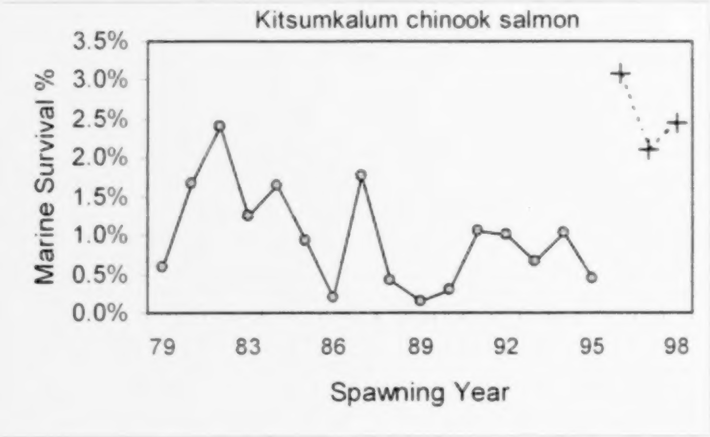


Figure 6.16. Estimated survival rate (% of smolts tagged) of Kitsumkalum summer chinook for the spawning years 1979-1998.

Values for 1996-1998 spawning years are forecasted due to incomplete returns to-date.

Chinook returns will also vary due to changes in fishing pressures. Fishing impacts by age and fishing location can also be estimated from coded-wire tag recoveries and are reported annually by the Chinook Technical Committee of the Pacific Salmon Commission. The proportion of the adult production from one spawning year that was killed over all ages and fisheries is the exploitation rate on the stock. For Kitsumkalum summer chinook, recent exploitation rates have varied from about 30% to 40% and have been slightly lower in more recent years. These reductions would contribute to the increased escapements but are not likely to account fully for the observed increases (see Table 6.3 for the fisheries that catch this stock). The increases could also be associated with hatchery releases, but these have been limited to levels required for tagging the indicator stock. Annual estimates of the hatchery contribution to the total escapement have averaged 2.5% since 1984, with a maximum value of 7.7% in the 1997 return.

In general, chinook escapements to the numerous spawning populations in the Skeena sub-area continue to improve in recent years. However, as these examples in the Skeena demonstrate, diverse populations even in one watershed can have different escapement trends and status, and require careful review before any explanation for trends is likely to be meaningful.

The above discussions provide some information on escapement methods but for comparison with other species in this report, this section provides information on survey frequency in a format comparable to the other sections. Since 1950 and throughout northern BC, only about 25% of the streams have been surveyed 40 or more years (24 of 105 streams) and a similar number in less than 10 years (28 streams, Figure 6.17).

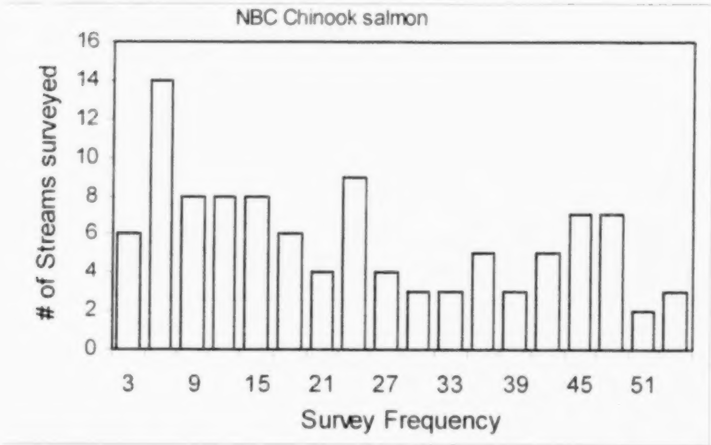


Figure 6.17. Frequency of northern BC chinook salmon stream inspections since 1950. *Survey Frequency is the number of possible surveys in the 53 year record. The Frequency axis is range of years inspected (e.g., bin 9 is the number streams enumerated between 7 and 9 years out of the 53 year total). Each bin includes 3 years, except the last that only includes 52 and 53 years.*

Over time, survey coverage in northern BC improved through the 1970s and 1980s until over 40% of all chinook streams were reported to be surveyed 8 or more years in each decade. Unlike some of the other species, during the 1990s, this survey frequency did not decline very much (still about 30% of the streams) and the decline would include the change in escapement methods in the Nass River. When examined by sub-area and time periods, the reduction in numbers of streams in the Nass sub-area is evident but the estimation of Nass River chinook returns has improved in recent years (Figure 6.18). The QCI sub-area is not included in this figure since there is only one stream and it is monitored each year (46 records in 53 years).

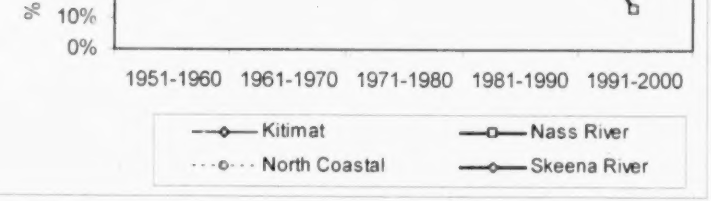


Figure 6.18. Changes in monitoring frequency by sub-areas and decades for northern BC chinook salmon. *Figure presents percentage of all streams surveyed (i.e., any stream with a record in a decade) in each sub-area that had at least 6 out of 10 visits in a decade. Total number of streams in each decade is 105.*

In the Kitimat, North Coastal, and Skeena River sub-areas about 50% of all chinook streams were monitored in 6 or more years during the 1990s. That sampling rate seems to have been maintained during 2001 and 2002 when 45 streams have been surveyed in each year and 61 streams in one of the two years. This sampling rate is lower than for some other species but could still provide an adequate appraisal of chinook returns depending on the distribution of the monitored streams.

In terms of the distribution of spawning population sizes between northern BC chinook streams, the diversity plots indicate significant change from the 1950s through the 1970s, but then a substantial recovery during the 1980s and 1990s (Figure 6.19). These plots relate the numbers of chinook in each spawning stream to the cumulative total number of chinook in all northern BC streams within each decade. The streams are ranked from largest to smallest number of spawners in each decade and then summed for the cumulative total number of spawners in each decade. For example, during the 1950s and 1990s, the largest ten chinook populations accounted for 77-78% of the total number of spawners in those decades. But, during the 1960s and 1970s, the largest ten populations accounted for only 55-60% of the cumulative totals. Curves that have a more gradual rate of increase indicate that the chinook spawners are more evenly distributed between streams, whereas a very rapid increase indicates that a few streams dominate the total number of chinook spawners.

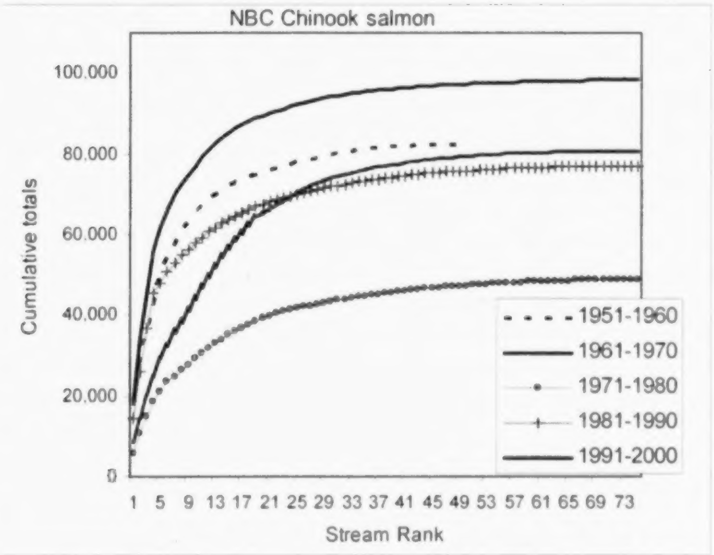


Figure 6.19. Cumulative total number of chinook spawning in northern BC streams by decade.

Streams are ranked from largest (1st rank) to smallest and then summed to give the cumulative total number of spawners.

To indicate how the largest chinook populations have changed over time, Table 6.4 compares the 15 largest chinook populations during the 1950s and 1960s to the top 15 streams during the past decade. These ranks will vary to some extent depending when a stream was first surveyed (e.g., the Bell-Irving River) and how they were surveyed, but many of the largest populations during the early periods remain the largest populations during 1991-2000. It is also interesting that this is true even when the enhanced chinook populations remain in the comparison. However, about half of the largest populations during the early decades are not included in the most recent decade.

Table 6.5. Largest 15 chinook spawning populations during 1951-1960 compared with their rank in the 1961-1970 decade (+ or – value indicates if average escapement size increased or decreased relative to the 1951-1960 average), and the top 15 populations during 1991-2000 and presence or absence of enhancement programs in those streams.

Stream & Rank 1951-60	Rank in 1961-70 (+ or -)	Stream & Rank 1991-2000	Enhanced (yes / no)
1. Bear River, Skeena	4-	Morice River, Skeena	No
2. Morice River, Skeena	2-	Kitimat River*	Yes, major
3. Babine River, Skeena	18-	Bear River	No
4.Damdochax River & Lake, Nass R	3-	Kitsumkalum River - Lower, Skeena	Yes, modest
5. Kispiox River, Skeena	33-	Kispiox River, Skeena	Yes
6. Kitimat River, Area 6	1+	Bell-Irving River, Nass R	No
7. Meziadin River & Lake, Nass R	23-	Kildala River, Area 6	Yes, major
8. Johnston Creek, Area 4a	13-	Damdochax River & Lake	No
9. Ecstall River, Area 4a	16-	Yakoun River	Yes
10. Kitlope River, Area 6	6+	Babine River	Yes, minor
11. Yakoun River, Qci	5+	Cranberry River, Nass R	No
12. Kemano River, Area 6	7+	Kwinageese River, Nass R	No
13. Tseax River, Nass R	14+	Nass Mainstem & Others**	No
14. Seaskinnish Creek, Area 3a	19+	Kitwanga River, Skeena	No
15. Cedar River, Skeena	53-	Skeena River - West & Upper Bulkley River	No

6.4 Chinook Enhancement in Northern British Columbia

Apart from small releases during the mid-1970s in Babine Lake and the Kitimat River, the major increase in hatchery releases of chinook salmon occurred in the early 1980s. In the Queen Charlotte Islands, the community development program at Masset has been supplementing Yakoun chinook production since 1979 and attempts have been made to establish chinook returns to the Pallant Creek. The majority of chinook enhancement in the Queen Charlotte Islands has, however, occurred at Masset with Yakoun chinook stock (Figure 6.20). The Yakoun chinook stock is a summer-run chinook and the juveniles are naturally 0+ smolts. Enhanced releases have followed that life-history type.

Release strategies for chinook may include release of fish in their first spring after hatching (releases may be fed or unfed-fry, unfed is now an uncommon strategy), or held until late spring or early summer and released as "smolts". Theses juvenile chinooks are expected to be a size that allows acclimation to seawater. The latter strategy is most common with fall or summer chinook that typically are under-yearling ocean migrants (0+ smolts).

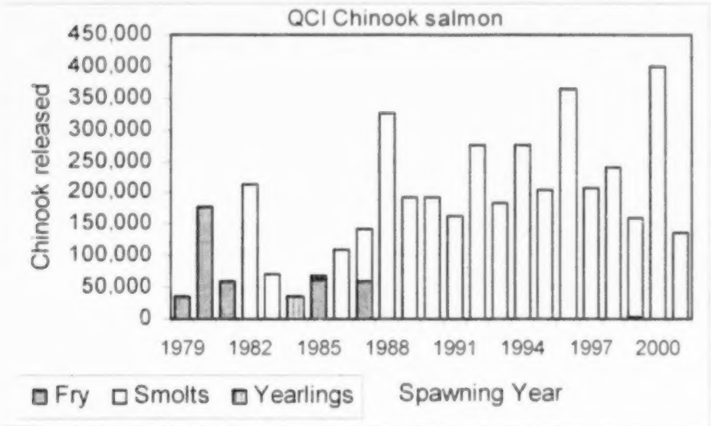


Figure 6.20. Releases of chinook salmon from enhancement programs on the Queen Charlotte Islands since 1979.

However, some chinook may be held in freshwater for a year after hatching and are referred to as 'Yearlings" (1+ smolts). These juveniles will be much larger than ocean-migrants released in their first spring/summer, and may be used in an attempt to increase the survival of fall or summer chinook. More typically, this strategy is used for spring chinook salmon. Spring chinook refer to the adults that migrate into freshwater in the spring and early summer, spawning in late summer and early fall, and have juveniles that spend one or more years in freshwater before emigrating. Typically, these spring chinook will use headwater habitats or systems that require up-stream migration during spring freshets and/or have very cool environmental conditions.

In the northern mainland sub-areas release strategies are more diversified due to the different types of chinook involved in enhancement programs (Figure 6.21). The largest enhancement program is the Kitimat Hatchery. Kitimat chinook are a summer-type chinook and the hatchery releases 0+ smolts, with the exception of some fed-fry released in the early years. Chinook released from Kitimat Hatchery may be released into the Kitimat River or a few other local streams including the Dala and Kildala rivers and Hirsch Creek. In other mainland areas, the release strategies are mixed. A community program near Prince Rupert, releases 0+ smolts into Kloiya River and Oldfield Creek and the Kitsumkalum River program uses 0+ smolt releases. However, other more interior Skeena programs may use a mix of 0+ smolts and yearlings (1+) smolts; for example programs in the Babine River, upper Bulkley River, and for the Cedar River in the upper Kitsumkalum drainage. The only longer-term chinook enhancement program in the Nass River area is in the North Coastal zone (Kincolith River, area 3A). This program usually releases 1+ smolts but has produced fed-fry and 0+ smolts in some years. Frequently, releases of smaller fish may indicate conditions such as surplus fish to rearing capacity or lack of funding to continue feeding. Smaller and less regular programs have also occurred in several interior Skeena tributaries, such as the Kispiox, Zymoetz, and Erlandsen.

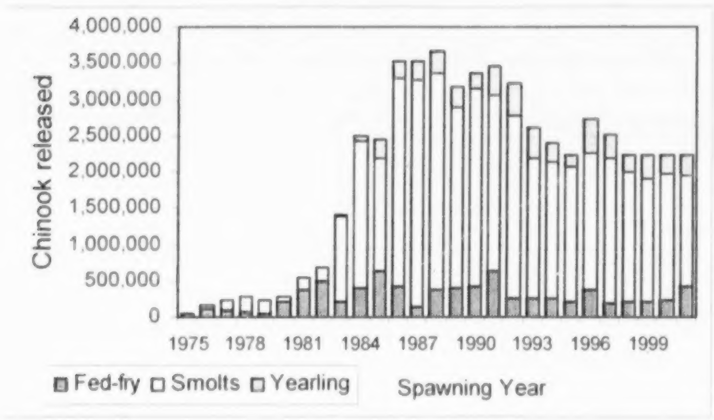


Figure 6.21. Releases of chinook salmon from enhancement programs in northern BC (Kitimat, Skeena, Nass, and North Coastal) sub-areas since 1975, excluding QCI sub-area.

6.5 Chinook Salmon Summary

The chinook in central and northern British Columbia are the most diverse of the Pacific salmon in terms of life history variations, although they are the least abundant species and utilize the fewest streams. Life history variation in chinook salmon is typically defined by differences in length of freshwater rearing by juveniles, seasonality of adult return migrations, and the size or age-at-maturity of adults. Juveniles may remain in freshwater for one or more years before migrating to the sea (termed 'stream-type' chinook, 1+ smolts) or may emigrate in their first year of rearing ('ocean-type' chinook, 0+ smolts or under-yearlings). Adults may return to freshwater in the spring to early summer (Spring chinook), or through the summer (mid-June to mid-August, Summer chinook), or in late summer and fall (Fall chinook). These return timings are frequently associated with environmental conditions that the adults must negotiate on their return to natal streams. Very large chinook may also be characteristic of certain populations such as the Kitsumkalum summer chinook or the Wannock River fall chinook.

In central BC (areas 7-11), chinook salmon have been reported in 30 different streams, but only nine streams have escapement records that average more than 100 spawners in each decade since 1950. Numerically, chinooks in central BC are dominated by returns to the Bella Coola River system including the Atnarko River and the Snootli Creek Hatchery. Returns to that system are frequently five to tens times the next largest chinook return in this area. Average returns to the central BC chinook streams were summarized in Table 6.1, and the biological traits for the major populations were described in Table 6.2.

In northern BC (areas 1-6), chinook salmon utilize substantially more streams (105 different streams reported since 1950) and have been consistently reported in about 83 streams. By sub-areas in northern BC, the Queen Charlotte Islands have only one chinook population (Yakoun River), the Kitimat, North Coastal, and interior Nass River each have about 14 streams with consistently reported chinook returns, and the Skeena River has about 40 chinook systems. Summarizing escapement trends over time for this diversity of Chinook systems is difficult. Chinook escapements generally declined through the 1970s and early 1980s, but escapements have increased since. The extent of increase in spawning escapements varies between streams depending on the run timing of the population (earlier returning runs have greater reductions in fishing impacts), the extent of enhancement in the system, and changes in marine survival rates.

There remain notable areas of concern, however, that cannot be explained without more specific investigations. For example, the decline in chinook returns to the Kitlope River, and the declines in escapement to several chinook streams in the North Coastal sub-area.

Enumeration efforts for chinook spawning escapements are highly variable between areas of central and northern BC. In central BC, only 9 chinook systems have been surveyed in over half of the years since 1950 and the methods used in some areas and years were poorly documented. The most thorough escapement assessments are in the Bella Coola/Atnarko system and the Dean River, and these surveys are being made more quantitative. In the north, the vast majority of the escapement surveys are based on visual counts and estimation of the total number of spawners, and the frequency of surveys has been better than in the central region. There are also limited exceptions to the visual methods. For example, since 1992 in the Nass River, a Nisga'a Tribal Council program has estimated the total return chinook salmon to the upper Nass River using a mark-recapture program. In the Skeena River, chinook salmon are counted as they pass the Babine River fence and since 1984 the Kitsumkalum summer chinook "indicator" program has been conducted. The latter program is the only indicator stock for central and northern BC Chinook, and was established to monitor the stock rebuilding program of the 1985 Pacific Salmon Treaty. This program involves annual coded-wire tagging of the stock and quantitative estimation of the annual spawning escapement using a mark-recapture program. These data are used to estimate the annual exploitation rates in fisheries, the catch distribution and timing of this stock, and marine survival rates for each brood or spawning year. Further, continuing reductions in Fisheries and Oceans Canada funding are reducing the numbers of streams that are surveyed each year. In central BC, and the Kitimat and the North Coastal sub-areas of the north BC, these reductions have resulted in a significant loss of information in recent years

Enhancement of chinook salmon in central and northern British Columbia involves two major hatcheries (Snootli Creek and Kitimat) and several smaller community programs. Enhancement strategies and releases of chinook in each sub-area are presented, but in many river systems an accounting of hatchery returns is not possible because of the unknown total escapement. In some streams with enhanced production, sampling programs provide estimates of the proportion of hatchery-origin fish in the spawning escapement even if the total number of spawners is not known.

6.6 Council Discussion

Conducting reliable stock assessments for chinook salmon and providing constructive advice on this issue presents significant challenges to both Fisheries and Oceans Canada and this Council. Chinook salmon have complex life histories, tend to utilize large river systems, have been heavily exploited by commercial, sport, and Native fishers, and have been extensively enhanced in some rivers. Each of these factors implies that assessment and management of chinook salmon should be more quantitative than qualitative. Unfortunately in the past, while exploitation rates were high and spawning escapement trends were declining, most of the information available for assessment was qualitative and the accuracy of the information largely unknown. For example, even a well-conducted visual survey of spawning escapements cannot provide critical information on the age-structured of spawning chinook salmon or differentiate hatchery-produced fish from natural fish.

The need for quantitative information for management has, however, been recognized by some groups and provides a basis for future developments. Enhancement programs have attempted to maintain tagging of released chinook to provide information on catch distributions, age-at-maturity, and timing of the stocks. Field and hatchery staffs in the Bella Coola system annually dedicate significant effort to estimating the total return of chinook and conducting an extensive sampling of carcasses to recover coded-wire tags in the escapement. Fisheries and Oceans Canada has supported one comprehensive indicator stock in the Skeena River (Kitsumkalum summer chinook), and the Nisga'a Tribal Council has supported new Nass chinook escapement programs. And recently, several programs have been initiated to improve the accuracy of spawning escapement estimates to the Dean, Kitwanga, Kwinamass, and Kwinageese rivers. The risk with numerous independent programs, however, is whether or not they collectively provide a basis for adequate overall assessment of chinook salmon in this region.

Such an assessment should consider key questions:

- What are the geographic and life history "races" of chinook salmon that need to be assessed and managed, and do the programs cover a sample of these chinook salmon?
- What are the critical population dynamic and fishery parameters that are needed for a quantitative assessment?
- What are the management objectives for chinook salmon and what level of mortality is sustainable by these chinook populations?

These questions lead naturally to a tiered plan for organizing the monitoring and assessment of chinook salmon, including the following tasks:

- Define the biological "races" or stocks of chinook salmon by geographic areas.
- Develop a few tagged indicator populations that can be used to monitor fishery exploitation rates and changes in marine survival rates (monitoring tagged indicator stocks is expensive and should prioritize populations with higher exploitation rates).
- Identify and develop escapement indicator streams that provide for quantitative estimation of spawning escapements and biological sampling of the spawners (untagged populations that can provide an accurate index of annual spawning escapements by race and geographic areas).
- Determine a sampling design to annually monitor a sub-sample of the total populations, for a qualitative examination of the spatial variation in escapement trends, distribution of spawners in streams, and habitat monitoring. Visual sampling methods may be appropriate for these broader surveys but they should still be conducted within an agreed sampling design.

Elements of such an approach are developing in central and northern BC, but there is limited indication that there is a design or plan that these developments are following. In the discussion of other species, this plan was referred to as an assessment framework. **The Council's primary recommendation, therefore, is to develop a chinook framework and associated annual monitoring programs for spawning escapements of naturally-produced chinook salmon within agreed racial groups.** The delineation of racial groups should strive to be consistent with the intent of the Canadian Species at Risk Act and meet public expectations to conserve biodiversity in this species. The identification of these groups might consider intra-specific differences in three types of attributes: biochemical genetics, life history traits, and ecological or habitat conditions. These attributes have been applied by Waples et al. (2001) to characterize diversity in Pacific salmon in the Pacific Northwest and have been initially applied by Fisheries and Oceans Canada to identify chinook groups in the Fraser River.

The Council's recommendation to monitor natural production is not intended to imply that enhanced production should not be assessed. Actually, the need to assess natural production will require increased monitoring of enhanced returns and consideration of interactions between hatchery and natural production. However, any long-term assessment of interactions requires the use of controlled or reference populations that are not influenced by enhanced production.

Chinook produced in hatcheries can only be identified in their first generation (i.e., tagged or marked releases sampled in the spawning population). The role of hatchery production in natural spawning and future production cannot be assessed directly and must be compared against a natural population without enhanced fish. There is no evidence that such assessments have been or are being planned.

There is also a broader issue of the need and/or value of the major hatchery programs given recent reductions in ocean fisheries. Both of the rivers with the largest chinook spawning escapements are associated with the two major hatcheries, but do the respective benefits or impacts of these hatcheries support the scale of these programs? Following reductions in ocean fishing impacts, the influence of these major hatcheries will increasingly be in terminal areas and the local communities. **It is reasonable to ask then whether or not the hatchery programs are providing the expected or desired benefits, or how they could be modified to aid other fish populations, assessment programs, or uses.** The evaluation of hatchery programs should involve the local communities in a deliberate and objective process.

In summary, while a nucleus of a chinook assessment program exists, the Council is concerned that a comprehensive program is not apparent (e.g., no tagged indicator stock for central region chinook), that the racial diversity and groupings are not well defined, and that the role of the major hatchery programs should be reconsidered.

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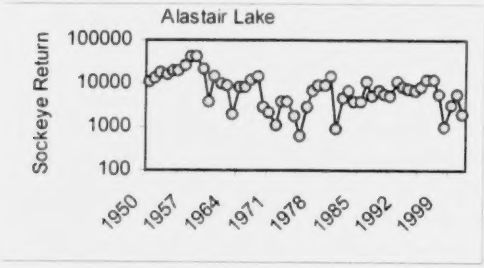
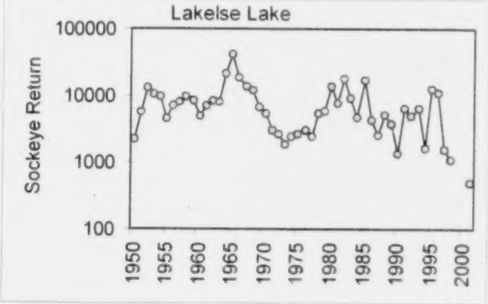
APPENDIX A

Appendix A. Examples of Sockeye return patterns to Skeena River populations since 1950.

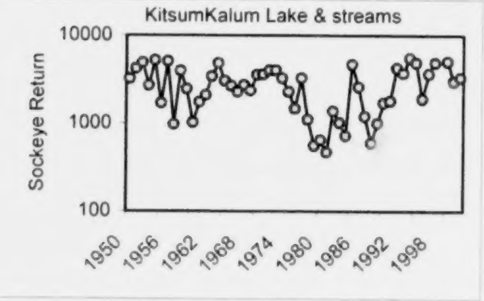
Data presented are spawning escapements recorded by calendar year and blank values on the plots indicate when no data was available from a survey, or no survey was conducted.



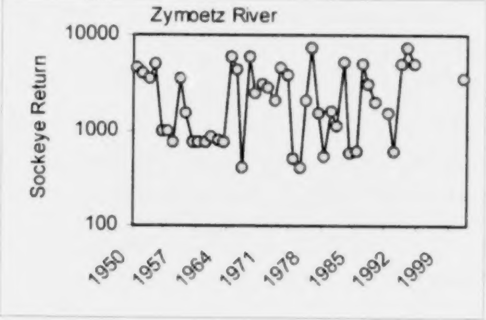
Alastair Lake & tributary spawning systems in upper Gitnadoix River.



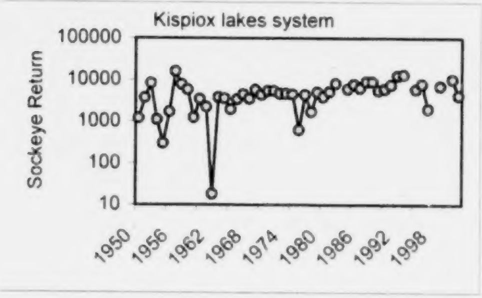
Lakelse Lake & tributary spawning systems



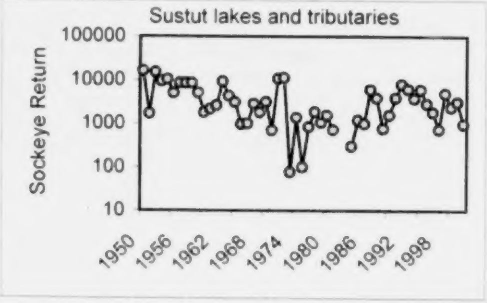
Kitsumkalum Lake & tributary spawning systems



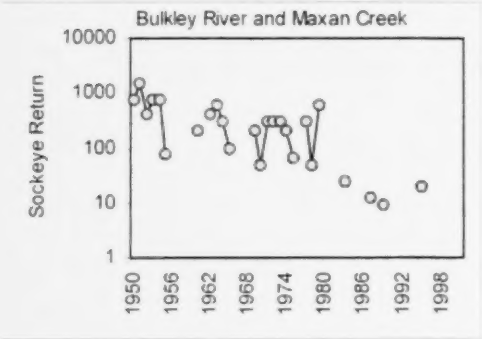
Zymoetz River system and upper tributary lakes (Aldrich, Dennis, and McDonnell).



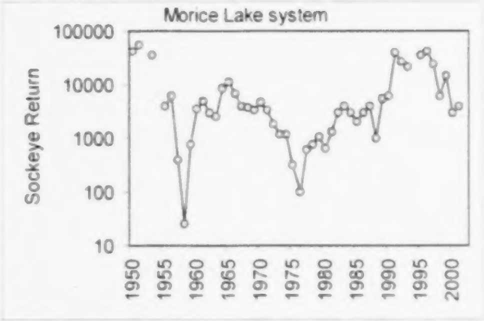
Kispiox River and lakes (Swan, Club, and Stephens lakes), including Nangeese River



Upper Skeena tributary, Sustut River and tributary lakes and streams. Lakes at elevations of 780m to 1450m.

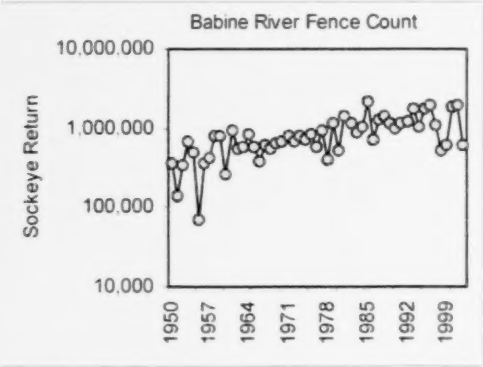


Bulkley River, Little Bulkley Lake and Maxan Creek and Lake, upper Bulkley drainage.

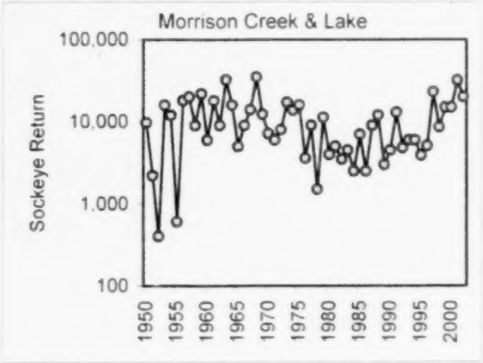


Morice River system includes Nanika River and Morice Lake sockeye.

Appendix A. Returns to Babine Lake and River, largest production center for sockeye salmon in the Skeena River system.



Total count of sockeye salmon returning to the Babine River fence operated by the Department since 1946. Fence count includes total escapement to the Babine Lake Development Program.



Morrison Lake tributary to the Babine Lake system of the Skeena River. Natural spawning population without production from a spawning channel.

APPENDIX B

Appendix B. Table of sockeye salmon systems in North coastal BC (Statistical areas 1 to 5) plus the Nass River watershed including Nisga'a Lands.

Watershed codes from BC Provincial Fisheries Inventory system. ***Figures referred to are in Appendix E and F***

Statistical Area	Spawning Stream and Lake, Location	Watershed code	Assessment and population size	Frequency of Assessments
1 QCI, Graham Is.	Yakoun Lake and river	940-896100	*See graph*, Long-term average escapement about 9,500 sockeye but with some reduction during the 1990s. Overall assessment of trend is **Stable**.	Good consistency of surveys since mid-1950s.
1 QCI, Graham Is.	Julan Lake and River	940-620200	Between 1969-1989, average population size was 1,400 sockeye. Recent values between 50-200 but limited surveys. **Depressed**	Between 1969-1989, 2 of 3 years with records, but only 3 observations since 1990.
1 QCI, Graham Is.	Ian Lake and Ain River, flows into Masset Inlet	940-768700	*See graph*, Early surveys indicated population size of a few thousand sockeye (median value = 1,500), but since 1990 only a few hundred recorded. **Depressed**	Between 1957-1989, every year was surveyed (except 1970), but only 4 of past 12 years observed.
1 QCI, Graham Is.	Mercer Lake and river	940-440100	*See graph*, early surveys averaged 4,400 sockeye: 1975 to 2000 average population size reduced to about 2,400 annually. Returns in 2001 and 2002 were 2,500 and 1,700 respectively. **Decreased, but stable recently.**	Annual surveys until 1973 and 2 out of 3 years since.
1 QCI, Graham Is.	Eden Lake and Naden River	940-665100	*See graph*, Large range of returns before late 1970s but overall average returns only slightly less during 1980-2000. However, 2001 and 2002 returns down to 400-800 sockeye. **Stable**, with recent concern	Good consistency of surveys since 1950 (48 of 53 observations).
1 QCI, Graham Is.	Awun Lake and River, flows to Masset Inlet	940-818300	*See Graph*, general trend is **Increasing** but some variation.	Consistent frequency of surveys since 1950s.

Statistical Area	Spawning Stream and Lake, Location	Watershed code	Assessment and population size	Frequency of Assessments
1 QCI, Graham Is.	Mamin River, Masset Inlet	940-874800	Between 1958-1979, median value was 75 sockeye; only 1 observation since, 50 sockeye in 1988. **Unknown**	Early surveys indicative of a population but no lake on system. No surveys in recent years.
2W QCI, Tasu Inlet, Moresby Is.	Fairfax Creek and Lake, small lake 34.8 ha	950-692400	Escapement generally > 1,000 sockeye but some decline in 1990s. Last record 1,200 sockeye in 2000. **Stable**	Consistent frequency of surveys between 1950-2000 (41 records in 51 years), but no surveys conducted in 2001 or 2002.
2E QCI, Louise Is.	Mathers Lake and Creek	955-081000	Between 1950-1979, median return value was 3,500 sockeye; decreased to an average of about 650 sockeye between 1980-2000 and only 400 recorded in 2002. **Decreased**	Limited early data, 1950-1979 only 8 observations; between 1980-2000 frequencies increased to 16 of 21 years. No data for 2001 but recorded in 2002. Long-term assessment is uncertain.
2E QCI, Moresby Is.	Skidegate Lake and Copper R.	950-010400	*See graph*, largest sockeye population on QCI, pre-1975 average return was 18,500, 1975-2000 average declined to 7,500 but during 2001 and 2002 has increased to over 11,000 a year. **Decreased**	Surveys conducted annually
2E QCI, Moresby Is.	Mosquito Lake and Pallant Cr	950-06500	Between 1950-1975 only 7 observations, median value = 75. In past 27 years, only 6 observations, median value = 20. Decreased but assessment highly uncertain. **Unknown**	Surveys very uncertain and not consistent evidence of a sockeye population, several barriers to Mosquito Lake.
3 Portland Canal	Bear River and Strohn Lake, upper Observatory Inlet	910-999400	Before 1980 the average return was 830 sockeye per year, ranging from 75 to 3,500. Few recent records for only 25 to 100 sockeye. **Depressed** but poor assessment.	Good consistency of records 1950 till early 1980s. Very few reports after 1982, none recently.
3 Work Channel	Several small lakes (e.g., Leverson lake system)	910-847300	No assessments, early observations indicate a few hundred sockeye. **Unknown.**	Rarely seen, very small numbers

Statistical Area	Spawning Stream and Lake, Location	Watershed code	Assessment and population size	Frequency of Assessments
3, Nass River	*Meziadin Lake and River*	*550*	*Largest sockeye production lake in Nass River, see text and graphs.* **Increasing trend in escapements.**	*Annual surveys via counts through a fishway. Good assessment basis.*
3, Nass River	Bowser Lake, Bell-Irving River	560-208600	*See graph*, second largest sockeye lake in Nass River. Range of escapements report from 6,000 to 120,000, with long-term average of 26,000 sockeye and no time trend. **Stable**, except for recent poor returns in 1999 and 2000.	Consistent frequency of records since 1964. Accuracy is unknown, and escapements in 2001 and 2002 are unknown.
3, Nass River	Fred Wright lake and Kwinageese River	500-571900	*See Graph*. Perception of long-term decline but very modest. Escapement in 2002 increased to almost 6,000 sockeye. **Stable**	Consistent annual frequency of surveys since 1964, except unknown in 2001.
3, Nass River	Brown Bear Lake	500-377100	Little information, 1978-1985 escapements ranged from 20 to 400. Status is **Unknown**	Only 7 observations since 1950, none since 1985.
3, Nass River	Damdochaux Lake and Creek	580	*See Graph*. Moderate sized population average 5,600 sockeye over first 30 years of observation. During mid-1990s declined to only 2,500 and escapement in 2002 only 183 sockeye. **Decreasing trend**	Consistent annual frequency of surveys since 1964, except unknown in 2001.
3, lower Nass River	Tseax River & Gingit Creek	500-185700 & 500-185700-00300	*See graph*. Stream-spawning sockeye populations. Returns quite variable over time, but long-term trend is declining. Escapement values for the 1990s indicate a **Depressed** status compared to the 1950-1989 average.	Surveys in Gingit Creek each year since 1950 through 1993 (missed only 3 years) but only 1 observation during late-1990s. Surveys less frequent in Tseux River but most spawners in the Gingit Creek. Observations during 2000-2002 in Gingit Creek.
3, lower Nass River	Seaskinnish Creek, lower Nass River	500-201900	Median value of escapement between 1956-1984 was only 120 sockeye. No other information. **Unknown**	Intermittent records from 1956-1984 but no records since 1984.

Statistical Area	Spawning Stream and Lake, Location	Watershed code	Assessment and population size	Frequency of Assessments
3, lower Nass River	Zaulzap River (Ksi Ts'oohl Ts'ap), lower Nass River	500-155400	Early records for 1959-1963 range 400-900 sockeye; 1976-1979 escapements decreased to 20 to 100 sockeye. Only 4 sockeye counted past fence in 2000. **Depressed.**	Infrequent surveys since 1959, counting fence operated in 2000. No other current information.
4A Coastal	Shawatlan Lake and River	910-797600	*See Graph.* Escapements increased relative to very poor returns in the 1970s. **Decreased** escapement levels but recovery in recent years.	Annual escapement surveys since 1950, very few years missed.
4A Coastal	Prudhomme Lakes and streams	910-791900	*See Graph.* Escapements reduced from earlier years but relatively **stable** in recent years. Also recovered from 1970s.	Annual escapement surveys since 1950, very few years missed.
4A Coastal, lower Skeena R.	Johnston Lake and Ecstall River	400-016500-5000	*See Graph.* Escapements in early years very uncertain. Returns **stable** and increasing population size in recent years.	Annual escapement surveys since mid-1960s, only a few years missed.
4B to 4D, Skeena River	***See Table2.1 for summary of sockeye production in non-Babine Lakes***			
5, lower Grenville Channel	Belowe Creek & Lake	910-736000	Unknown, obstructions in lower river.	Noted as a sockeye system in Provincial inventory but no real evidence in DFO escapement records
5, Banks Is	Bolton Creek, series of small lakes on east Banks Island	915-560000-75100	Previous to 1990, escapement varied from 25-1500 sockeye, but only 50 recorded in 1991 and 1993. Status is **Unknown**.	Limited observations, only 11 years during 1950-1990. Last observation in 1993.
5, Pitt Is	Devon Lake and Creek	915-560200-24900	*See Graph.* Moderate size population of a few to several thousand sockeye. Relatively **stable** long-term production but decreased in 2002.	Annual escapement records since 1950 with only 1 year missed through to 2002.
5, Pitt Is	Curtis Lake & Curtis Inlet Cr	915-560200-34300	*See Graph.* Moderate size population of a few thousand sockeye before 1980. Recorded escapements are much more variable after 1980 and average production has **decreased**. Only 300 reported for 2002.	Annual escapement records since 1950 with only 5 years missed through to 2002.

Statistical Area	Spawning Stream and Lake, Location	Watershed code	Assessment and population size	Frequency of Assessments
5, Pitt Is	Mikado lakes & Creek, west coast Pitt Is.	915-560200-23700	*See Graph*. Very **stable** production over time, no temporal trend.	Annual escapement records since 1950 with only 2 years missed through to 2002.
5, Pitt Is	Hevenor Inlet Creek, upper west coast of Pitt Island	915-560200-58300	Limited assessment, observations 1960-1968 indicate 400-750 sockeye. Only 4 observations since 1970 with a range of 10-150 sockeye. **Unknown** status but likely depressed.	Only series of observations between 1960-1968. No observations after 1990.
5, Pitt Is	Monckton Inlet Creek and lakes, bottom of Pitt Is.	915-560200	Complex of small systems, limited assessment data. Initial observations about 600 sockeye per year, but by 1987-1992 records of only 50-150 observed. Status is **Unknown** but likely depressed.	Early records from 1953-1968 but subsequently only 4 years between 1987-2002. No recent assessment of spawners.
5, Pitt Is	Cridge Inlet Creek & Tuwartz Lake, bottom of Pitt Is.	915-560200-93500	Obstruction at outlet of Tuwartz Lake, average return 1950-1970 was 2,200 sockeye. Major decline to 75 fish in 1970. Four later records only 25-50 fish. Status **Unknown** but likely depressed.	Observations from 1950-1970 but only 4 subsequent records through 2002.
5, Banks Is	Bonilla Lake & Bonilla Arm Creek	915-560000-37600	*See Graph*. Moderate sized sockeye population, decreasing trend through to mid-1990s, but increasing returns after. Long-term status **Stable**	Annual escapement records since 1950 with only 1 year missed through to 2002.
5, Banks Is	Banks Lakes & Quitonsta Creek	915-560000-25100	*See Graph*. Moderate sized sockeye population, early observations averaged 5,000 per year. For 1983-2000, decreased to 2,800 average. Some evidence of reduced return but relatively **stable** over time. Last record of return was 4,000 sockeye in 2000	Good series of early observations from 1950-1975. Records from 1983-2000 (3 years missed), but no observations for 2001 or 2002.
5, Banks Is	Kooryet Lake and Creek	915-560000-78400	*See Graph*. Pre-1974, escapements averaged about 3,000 sockeye. Since 1980, values have averaged about 2,000 sockeye and increasing in recent years. Long-term status **Stable**.	1950-1974 records for each year; 1980-2001 records for all but 3 years. No observation for 2002.

Statistical Area	Spawning Stream and Lake, Location	Watershed code	Assessment and population size	Frequency of Assessments
5, Banks Is	Keecha Lake and Creek	915-560000-80400	Moderate sized sockeye population, range of escapements in 1950-1973 was 200-15,000 (median value = 1,500). In more recent period, range is 100-5,000 but median value = 1,800. **Long-term Stable**.	Annual surveys from 1950-1973; only 1 survey until 1983, more consistent since 1983 with only 3 years missing. No observation for 2002
5, Banks Is	Deer Lake and Creek	915-560000-82800	Surveys between 1950-1973 indicated escapements between 200-1500 (average 650); values between 1978-1993 ranged from 25-550, on average about half of the previous period. No current data. **Decreased**	Surveyed between 1950 and 1973, but infrequently after that. No observations after 1993.
5, Pitt Is	Tsimtack/Moore lakes, bottom of Pitt Is.	915-560200-87900	*See Graph.* Small to moderate sized population. Pre-1990, median observation is 1,500 sockeye per year. In recent decade, 1990-2001 median is the same but production highly variable. **Stable**	Good series of observations from 1950-2001, some decrease in frequency in recent years. No data for 2002.
5, Banks Is	Kenzuwash Creeks, outer Banks Island	915-560000-04600	Very limited information, 750 to 1500 sockeye reported during 1950-1973, but only two other observations. Fifty sockeye reported in last survey (1990). **Unknown**	Infrequent surveys, only 5 conducted between 1950-1973, and only two others to-date. None since 1990
5, Lowe Inlet, Grenville Channel	Kumowdah River and Lowe, Simpson & Weare lakes	910-740100	*See Graph.* Pre-1975 escapements appeared to be increasing. Escapements were more stable between 1977-1997 and were about one-half of the pre-1975 average. Escapements in 1999 to 2001 are depressed. **Long-term status Decreased**.	Annual surveys from 1951-2001 (3 years missed), but no observation for 2002.
5, west coast of Banks Is	Waller Lakes & Lewis Creek	915-560000-14700	Escapements from 1950-1979 ranged from 200-3500 (median = 1,500). Records for 1991 and 1992 only 25 to 200 sockeye. Status is **unknown** but likely depressed.	Annual surveys 1950-1979 (25 of 30 records), but only 2 subsequent surveys. No survey in past decade.
5, upper Principle Channel	Kumealon Lake	910-768900	Small system with an obstruction at the mouth of the lake. Records of only 5 to 100 sockeye. No assessment.	Rare observations of sockeye, only 3 records since 1950.

Statistical Area	Spawning Stream and Lake, Location	Watershed code	Assessment and population size	Frequency of Assessments
5, Ogden Channel	Captain Cove Creek	915-560200-66500	Relatively small population, 1953-1974 averaged about 630 sockeye, reduced to 230 between 1975-1988, and only 10-100 sockeye in most recent records. **Depressed.**	Observations for most years 1953-1989 but only 2 years after 1990. No observations since 1992.
5, upper Principe Channel	Ryan Creek, McCauley Is.	915-742200-93300	Small system, approx. 1,200 sockeye recorded during 1960s, dropped to 200-400 in early 1970s. Observations between 1986-1990 decreased to 25-250, no data for later years. **Depressed**, but recent status unknown.	Escapement recorded from 1960 to 1974 but very limited after. No observations in past decade.
5, upper Principe Channel	Keswar Creek, outer McCauley Is.	915-742200-32600	Early observations ranged from 200 to 1500, and between 100-500 for the 1978-1981 period. Only 30 sockeye recorded for 1992. Limited data, **Unknown** status but likely depressed.	17 of 24 observations between 1950 and 1973, data for 1978-1981, but only 1 observation since 1981.
5, Banks Is	End Hill Creek, NE shore Banks Island	915-560000-62900	Chain of small lakes with about 3000 sockeye per year until late 1960s; slow decline in production since; but no data after 1994. Last record was 400 sockeye in 1994. **Depressed** but current status unknown.	Annual surveys in 35 of 40 years between 1950 and 1989, but only one survey (1994) since.
5, Principe Channel	Sheeneza Creek, west Pitt Is.	915-560200-39100	Small system, early observations average 600 sockeye return. Values in 1990-1992 only 100-225 sockeye. **Decreased** but current status unknown.	1950-1978 records each year (except 1), but only subsequent data for 1990-1992. No more recent data.
5, Grenville Channel	Salter Lake Creek, east Pitt Is.	915-560200-82200	Small system, early observations indicate 300-750 sockeye, but no current data and status **Unknown.**	Very few records, 5 observations between 1951 and 1972. No information after 1972.
5, upper Principe Channel	Spencer Creek, NE Banks Is.	915-560000-69500	Small system, early records average 500 sockeye per year. Only recent data for 2000 & 2001, 300 to 500 sockeye. Appears **Stable** but poor assessment quality.	Observations from 1953-1974 but rarely after that, until surveys in 2000 and 2001. No data for 2002.

Statistical Area	Spawning Stream and Lake, Location	Watershed code	Assessment and population size	Frequency of Assessments
5, Grenville Channel	Brodie Lake, & Klewnuggit Inlet Creek	910-748900	All records before 1985 were either 200 or 400 sockeye. Escapements since 1985 ranged from 100 to 2,000 sockeye. Long-term change is unknown but escapement **increasing** relative to past records.	Limited information until 1985, 1985-2001 records except for 1 year, and no data for 2002.

APPENDIX C

Appendix C. Table of sockeye salmon systems in Kitimat area of north BC coast (Statistical area 6).

Watershed codes from BC Provincial Fisheries Inventory system. Figures associated with this table in ***Appendix G.***

Statistical Area	Spawning Stream and Lake, Location	Watershed Code	Assessment and Population Size	Frequency of Assessments
6, Laredo Inlet	Bloomfield Creek, Princess Royal Is.	915-488300-07700	*See Graph*. Returns from 1950 to mid-1980 were highly variable. Since the low in 1984 (only 30 sockeye recorded), escapements have been increasing. Long-term status **Stable**.	Annual reporting of escapements since 1970.
6, Hecate Strait	Borrowman Creek & Stannard Creek, NW shore Aristazabal Is.	915-483500-62700	Returns during 1950-1964 range from 600 to 4,000 sockeye, but declined through the 1980s. Last observation was only 8 sockeye in 1997. **Depressed**, but no recent data.	Annual reports for most years until 1988. However, after 1988 there are only 2 records and no data since 1997.
6, Laredo Inlet	Busey Creek, Princess Royal Is.	915-488300-18800	No data since 1964, early observations between 200 and 750 sockeye. Status is **Unknown**.	Only 9 observations between 1950 – 1964. No other data.
6, Fraser- Graham Reach	Canoona Creek, NE shore Princess Royal Is.	915-488300-84200	Three observations in 1960s ranged from 50-3500 sockeye. Escapements increased into 1990s and now quite **stable**. Average spawners in past decade 1,700 sockeye.	Annual surveys recorded since 1975.
6, Hecate Strait	Clifford Creek, outer SW Aristazabal Island	915-483500-35000	No trend in production between 1950-1965, average return about 1,000 sockeye per year. Current status **Unknown**.	Only records for 1950-1965. No later records.
6, Laredo Channel	Dallain Creek, SE shore Princess Royal Island	915-488300-27300	Small sockeye system, average return 400 during 1950-1964. Current status **Unknown**.	Records for 1950-1964, and no observations since 1974.
6, Laredo Sound	Don Creek, SE shore Aristazabal Island	915-483500-97900	Similar to Dallain Creek, observations during 1950-1963 ranged from 25 to 750 sockeye. No other records, current status **Unknown**.	Only records for 1950-1963, no later records of sockeye spawning.

Statistical Area	Spawning Stream and Lake, Location	Watershed Code	Assessment and Population Size	Frequency of Assessments
6, Chapple Inlet	Douglas Creek, west shore Princess Royal Island	915-488300-55800	Small chain of lakes, records for 1958-1964 vary from 75-750 sockeye. **Unknown**.	Records only for 1958-1964 and 2 subsequent years. No current data.
6, Hecate Strait	Duffey Creek, lower west shore Aristazabal Island	915-483500-15800	Data for 1950-1966 ranged from 75 to 3500 sockeye. Only other record in 1998 reported 2 sockeye. Status **Unknown** but likely depressed.	Records only for 1950-1966 and one entry for 1998. No other current data.
6, Hecate Strait	Eagle Creek, mid-west shore Aristazabal Island	915-483500-54600	Data for early period indicate a median return of 1,500 sockeye, during 1977-1987 median value decreased to 250 sockeye. **Depressed**, no recent data.	Records for 1950-1965, and for 7 years between 1977 and 1987. No more recent data.
6, Douglas Channel	Evelyn Creek, Hawkesbury Island	915-567300-72300	*See Graph*. Long-term decline in escapement until 1997, followed by increasing trend through 2002. Sockeye escapement in 2002 = 1,200. Long term variable but now **Stable**.	Annual records of escapement since 1950, only 4 years missed through 2002
6, Laredo Channel	Evinrude Creek, W shore Princess Royal Island	915-488300-38700	Range of escapement for early period 200-750 sockeye, decreased to 75-250 sockeye in later period. Status **decreased** but currently uncertain.	Limited data for 1958-1964 and 1977-1987. No current information.
6, Hecate Strait	Flux Creek, west shore Aristazabal Island	915-483500-35100	Sockeye present but assessment **unknown**. Only 5 sockeye reported in last survey in 1997.	Very limited data, only 5 observations since 1950.
6, Laredo Channel	Fury Creek, east shore Aristazabal Island	915-483500-86200	Observations through to 1975 indicate 50 to 750 sockeye spawners. Records for 1985 and 1986 were 300 to 350. Assessment uncertain, status **Unknown**.	Records for 1950-1964, but only 4 records since. No observations since 1986.
6, Laredo Inlet	Quigley Creek, S shore Princess Royal Is. (note alias: Fury Cr but **not** the same as above)	915-488300-01500	During 1950-1965, escapement ranged from 50 to 1,500 sockeye (median = 400). Most recent record of 25 sockeye in 1997. Status **Depressed**, limited data.	Records for 1950-1965, but only 2 late observations. One survey in past decade.

Statistical Area	Spawning Stream and Lake, Location	Watershed Code	Assessment and Population Size	Frequency of Assessments
6, Graham Reach	Green Inlet Creek, Green Inlet	910-533000	Very small numbers, ranging from 2 to 55 sockeye per year. Not likely a separate population. **No assessment.**	Records for 1985 through 2001, no 2002 observation.
6, Higgins Passage	Gull Creek, SW Swindle Island	915-482000-13200	Small chain of lakes, escapement values range from 10-400 sockeye. Status **Unknown**.	Only 8 observations since 1950, none since 1985.
6, Douglas Channel	Hartley Bay Creek (Gabion River)	910-728100	Relatively small sockeye population with evidence of a slow decline in numbers of spawners. Long-term decline from approx. 600 sockeye per year to 400 during past decade. Relatively stable return but **decreased**.	Records of escapement since 1955 (37 observations in 48 years) through 2002.
6, Hecate Strait	Kdelmashan Creek, SW shore of Aristazabal Island	915-483500-19900	Observations from 1959-1987 indicated an annual return of 300 to 1,500 sockeye, but in 1988 only 1 sockeye was reported. No subsequent records, current status **Unknown**.	Escapement observations for 1959-1988, but none since then.
6, Gardner Canal	Kemano River	910-627400	Annual reports of sockeye vary from 10 to 400 spawners, median value = 65. Source of these sockeye is uncertain.	Reports of sockeye in most years since 1967.
6, Kitimat Arm	Kitimat River	910-673500	*See Graph.* Highly variable returns but no long-term decline. **Increasing** trend over the past 2 decades.	Reports of sockeye in most years since 1975 through 2002.
6, Douglas Channel	Kitkiata Creek	910-713300	*See Graph.* Escapement values pre-1987 varied from 750 to 5,000 sockeye, but declined in 1988. **Depressed** escapements, no recent recovery observed.	Consistent record of escapement 1950-1990, but records only about 1 in 2 years recently.
6, Gardner Canal	Kitlope River	910-617600	*See Graph.* Largest sockeye escapements in Area 6. Quite **stable** returns but less variable in recent years than in earlier period.	Annual escapement records for each year 1950-2002 (except for 1952).

Statistical Area	Spawning Stream and Lake, Location	Watershed Code	Assessment and Population Size	Frequency of Assessments
6, Kitasu Bay	Kwakwa Creek, Swindle Island	915-482000-59900	*See Graph.* In period before 1970, median escapement values = 3,500 sockeye per year. During 1974-2002, the median has declined to 1,000 sockeye. Long-term status **decreased** but stable more recently.	Annual escapement records for most years 1950-2002.
6, Laredo Channel	Limestone Creek, NE shore Aristazabal Island	915-483500-83800	Median escapement during 1969-1987 was 400 sockeye (range 20-6,000). The only other observation was 20 sockeye in 1991. Current status **Unknown**, but likely depressed.	Escapement records for 1969 to 1987, but only in 1991 after that period. No recent observations.
6, Hecate Strait	McDonald Creek, NW shore Aristazabal Island	915-483500-36000	While the first escapement record in 1957 was 3,500 sockeye, all other entries are less, with a median = 275 over the period of record. Current status **Unknown**.	Escapement records for 1957-1982, but no observations since.
6, upper Laredo Channel	Nias Creek, Princess Royal Is.	915-488300-13600	Evidence of a small population, access to two small lakes with obstruction at mouth of lower lake. Since 1980, records vary from 1 to 40 sockeye, median = 15. Status **Unknown**, but very small.	Infrequent surveys until 1980, 14 of 23 years recorded since 1980, no record for 2002.
6, Hecate Strait	Noble Creek, SW shore Aristazabal Island	915-483500-18300	During the 1957-1967 period, escapement records ranged from 25 to 1,500 sockeye. Current status **Unknown**.	Limited data, only for 1957-1967 period. No other escapement records.
6, lower Laredo Channel	Powles Creek, Princess Royal Is.	915-488300-02700	Series of several small lakes. During 1950-1964 period, approx. 200 sockeye per year. In the 1984-1993 period, records ranged from 25 to 125 sockeye, and only 1 spawner observed in 1998. **Depressed**.	Two periods of records; 1950 to 1964 and later between 1983 and 1993. One subsequent survey in 1998, none more recently.

Statistical Area	Spawning Stream and Lake, Location	Watershed Code	Assessment and Population Size	Frequency of Assessments
6, Laredo Sound	Price Creek, Price Island	915-470000-54500	*See Graph.* Pre-1975, median escapement value was 1,150 sockeye. Post-1975, median value reduced to 500 sockeye. Escapements **decreased**, but some indication of increases recently.	Annual escapement records for most years 1950-2002. Only about 1 in 2 years since mid'90s.
6, Douglas Channel	Quaal River	910-713900	Records (n=4) before 1970 indicate 400 to 7,500 sockeye. Since 1980, escapement values much smaller, median value = 25 (n=13). Status **Unknown** due to unknown values pre-1980.	Seven records before 1980, but frequency of records increased to about 1 in 2 years since (includes 2002)
6, Hecate Strait	Salmon Creek, NW shore Aristazabal Island	915-483500-54100	During 1950-1964, range of escapements was 100 -750, median value = 400 sockeye. Current status is **Unknown**.	Data only for 1950-1964, no observations after this.
6, Hecate Strait	Sentinel Creek, SW shore Aristazabel Island	915-483500-28300	During 1950-1963, range of escapements was 75 to 1,500, median value = 750 sockeye. Current status is **Unknown**.	Data only for 1950-1963, no observations after this.
6, Laredo Channel	Talamoosa Creek, bottom of Princess Royal Island	915-488300-30600	*See Graph.* During 1950-1964 period, escapements average about 1,400 sockeye. Since 1975, escapements have **decreased** by about one-half.	Records for 1950-1964, and subsequently after 1975. Since 1975, records for 17 of 28 years including 2002.
6, south of Surf Inlet	Wale Creek, W shore Princess Royal Island	915-488300-43300	Early records vary from 25 to 400 sockeye, increased to 100 to 1,000 sockeye in later period. Current status **Unknown** but likely stable.	Infrequent data for 1950 to 1972. More frequent records for 1973-1987, but no data after that.
6, Douglas Channel	Weewanie Creek, Devastation Channel	910-649000	One small tributary lake, escapements were 75 to 400 sockeye. Unable to assess, status **Unknown**.	Observations only for 1950 and 1951.

Statistical Area	Spawning Stream and Lake, Location	Watershed Code	Assessment and Population Size	Frequency of Assessments
6, Beauchemin Channel	West Creek (alias: Fish Creek), top of Aristazabal Island, chain of several lakes	915-483500-63900	During 1950-1964, median escapement value = 200 sockeye. Subsequent surveys reported 25 to 200 sockeye. Limited assessment data, status **Unknown** but likely decreased escapements.	Data for 1950-1964, and then 4 surveys in 1976-1986, but no subsequent data. Some recent surveys but no sockeye observed.

APPENDIX D

Appendix D. Table of sockeye salmon systems in Central BC coast (Statistical areas 7 to 11).

Watershed codes from BC Provincial Fisheries Inventory system. Figures associated with this table in ***Appendix G****.*

Statistical Area	Spawning Stream and Lake, Location	Watershed Code	Assessment and Population Size	Frequency of Assessments
7	Choke Pass Creeks (3), Hunter Island.	915-213000-62700, 60800, 59400	Infrequent records of a few hundred spawners, no observations after 1981. **No assessment.**	Only 7 entries since 1950, none after 1981.
7, Roscoe Inlet	Clatse Creek & Lake, access limited at mouth	910-385700	Infrequent observations of sockeye, 10 entries since 1950, all ≤ 20 sockeye. Last entry was 15 spawners in 2000. **No assessment**	Infrequent records (n=10) since 1950. Last record in 2000.
7, Lama Passage	Cooper Inlet Creeks, top Hunter Island	915-213000-68600	*See Graph*. Escapements maintain about 1,000 sockeye until 1981. After 1981 strong declining trend in escapement. Only 25 sockeye in most recent two years. **Depressed.**	Surveys in most years since 1950, except between 1994 and 1999. Observations again in 2000 & 2001.
7	Deer Pass Lagoon, Cunningham Island	915-233500-50100	Small population, early period escapements averaged about 250 sockeye. However, last two observations were only 50 to 75 sockeye. Current status **Unknown** but likely depressed.	Surveys for 1950 to 1974, and 1976 and 1977. No other surveys subsequent to 1977.
7, Kynock Inlet	Kainet Creek, in Fiordland Recreational Area	910-500000	*See Graph*. Escapements quite stable over long-term, and **increasing** since 1981.	Annual surveys since 1951, except for 7 years of observations, including 2002.
7, Seaforth Channel	Kakushdish River, north shore Denny Island, near Bella Bella (Kadjusdis River also)	915-230500-47800	*See Graph*. Long-term escapement quite stable until data stops in 1991, escapement about 1,000 sockeye. Only 10 sockeye recorded in 1999. Current status **Unknown** but likely depressed.	Annual records for 1952-1991 but only 1 record (1999) subsequently.
7	Kildidt Creek, south end Hunter Island	915-213000-09900	**No assessment** possible, early records were 300 to 550 sockeye.	Only records for 1952-1955.

Statistical Area	Spawning Stream and Lake, Location	Watershed Code	Assessment and Population Size	Frequency of Assessments
7	Kwakusdis River & Yeo Lake, Yeo Island north of Bella Bella	915-381700-84400	Escapements about 1,000 sockeye from 1950 to 1970 but escapements declined after this. Between 1982 – 1992, median escapement value decreased to 100 sockeye. **Depressed**, but no recent data.	Escapement records for most years 1950-1992, but no data for more recent years.
7, Finlayson Channel	Lagoon Creek & Roderick Lake, Roderick Island (obstruction at outlet of the lake)	915-486500-05300	Escapement records quite variable. Early period median value was 400 sockeye per year. During 1992-2002, median value **decreased** to 175 sockeye. Some recent indication of increasing escapements.	Escapement records for early period (until 1974) and later period (after 1991). Period of no records in 1975 to 1985.
7	Mary Cove Creek, just north of Lagoon Creek	915-486500-06800	*See Graph*. Long-term decline in escapements since mid-1970s. Previous values over 1,000 sockeye, but in past decade, median value only 190 sockeye. **Depressed** status.	Escapement records for almost all years since 1950 through 2002 (3 years missed)
7, near Bella Bella	McLoughlin Bay Creek, Campbell Island.	915-228000-69600	Long-term declining trend in escapements, stronger after mid-1970s. Early periods escapements were a few hundred but declined to below 100 in early 1990s. No data after 1995. **Decreased** status.	Escapement records for most years 1950-1995. No records after 1995. Large variability in escapement records.
7, Mussel Inlet	Mussel River, top of Mathieson Channel, Fiordland Recreational Area	910-514200	Infrequent records since 1950, all recorded escapements less than 50 sockeye. **No assessment**, last record 10 spawners in 1997.	Only 13 survey records between 1950 and 2002.
7	Pine River, top of Spiller Inlet	910-441000	Records for early period ranged from 75 to 1,000 sockeye. Most recent record was 6 sockeye in 2000. Current status **Unknown** but likely depressed.	Records for 1952 to 1974 but only two records after 1974. Last record in 2000.
7	Ship Point Creek, Campbell Island	915-228000-76500	Early records varied from 50 to 800 sockeye and without any time trend. However, records in mid-80s were all less than 10 sockeye. Status **Unknown** but likely depressed.	Records for 1950 to 1977 but only 3 other observations 1985-87. No records after 1987.

Statistical Area	Spawning Stream and Lake, Location	Watershed Code	Assessment and Population Size	Frequency of Assessments
7, Spiller Channel	Tankeeah River, Don Peninsula	910-463800	*See Graph.* Strong decline in escapements from a few thousand sockeye before 1970 to a few hundred in the 1990s. In 2001 though escapement recorded was 1,000 sockeye. **Depressed**	Annual escapement records for every year 1950 to 1994, but only records for 1997 and 2001 after that.
7	East and West Tuno Creeks, south outer coast of Don Peninsula	910-470600 910-471700	*See Graph* of combined escapements for East and West Tuno Creek. Strong decline in escapement averaging about 1,000 sockeye until the late 1970s, but only tens of sockeye in the 1990s. **Depressed**	Annual escapement records from 1950 to 1979, but only 9 records since (through 2002).
7, Milbank Sound	Yaaklele Lagoon, Athlone Island (extreme outer coast)	915-233300-36400	Small sockeye population, median escapement value between 1950-1977 was 200 spawners (range 25 to 750). No other data. Current status is **Unknown**.	Annual records from 1950 to 1977 but no escapement records after that.
8, South Bentinck Arm	Asseek River and Michel Lake (past Bella Coola)	910-273700	No data before 1977, infrequent records since, all values less than 50 sockeye. **No assessment**.	13 observations between 1977 and 1996. No more recent data.
8, Burke Channel, North Bentinck Arm	Bella Coola River and Atnarko lakes (Elbow, Rainbow, and Lonesome)	910-290700	*See Graph.* Large sockeye population with early escapement levels averaging 60,000+ sockeye. While escapement levels have remained large, recent average values are about one-half of the earlier periods. Status **Decreased** but returns quite stable.	Annual escapement records for each year.
8, Dean Channel	Cascade River, Cascade Inlet	910-351200-12100	Common to observe between 1 and 100 sockeye a year. Cascade at mouth of the river. **No assessment**.	No records before 1972, records for about 2 of 3 years since.
8, Dean Channel	Dean River, upper Dean Channel	910-318700	*See Graph.* Early records are limited but the spawning population size was about 1,000 sockeye until 1977. Decreased to only a few hundred through the 1990s, but increased to 3,000 spawners in 2000. Currently assessed as **Depressed** but may be improving.	Fragmented data series with only 31 records in 53 years (since 1950).

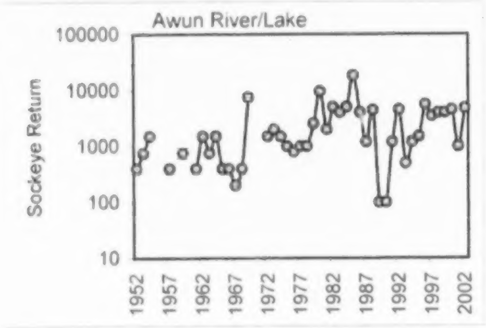
Statistical Area	Spawning Stream and Lake, Location	Watershed Code	Assessment and Population Size	Frequency of Assessments
8, mid-Dean Channel	Elcho Creek, near Ocean Falls	910-361300	A few sockeye up to 120 sockeye recorded since 1982. Median value = 20 sockeye. **No assessment**. (falls at lake mouth)	Records for most years from 1982 to 2002.
8, Fitz Hugh Sound	Fish Egg Creek and Elizabeth Lake, mainland side of Sound	910-193700-60500	Very limited data, between 200 and 400 sockeye recorded between 1950 and 1956. Current status **Unknown.**	Survey records only for 1950 to 1956, no subsequent data.
8, Fisher Channel	Hook Nose Creek and Port John Lake, King Island	915-226500-31800	*See Graph*. Long-term decline in escapement values. During 1950s, number of spawners over 1,000 sockeye. Decreased to only about 100 sockeye in the 1990s. Assessment concern for how comparable data is with the FRB, but escapements are likely **depressed**.	Records for 1950s from Fisheries Research Branch project. Subsequently, records for most years from 1960 to 2002 (most limited in the 1960s)
8, upper Dean Channel	Kimsquit River and Lake	910-322400	*See Graph*. Slight increase in long-term escapement trend until 1996, but last 3 data entries are substantially lower (1,000 to 5,000). Long-term trend **stable**, but recent concerns.	Records for most years since 1950 but less frequent entries since 1994. No observations for 2001 or 2002.
8, Fisher Channel	Kisameet River, bottom of King Island	915-226500-10000	*See Graph*. Long-term decline in numbers of spawners. Early years averaged > 1,000 sockeye but decreased to about 100 in 1990s. Returns **depressed**, recent year data is uncertain.	Records for 31 of 53 years since 1950, and there are periods of annual surveys and then periods of less frequent surveys. Only 2 records between 1994-2002.
8, Fitz Hugh Sound	Koeye River & Lake, mainland side of Fitz Hugh	910-212200	*See Graph*. Limited evidence of some decline over time, but recent years increased. **Stable**	Records for most years (46 of 53 years), including 1999 to 2002.
8, Fitz Hugh Sound	Namu River and Lake, near Namu	910-216500	*See Graph*. Similar to Koeye River, limited indication of a decline over time, but recent years are increasing. Long term status is **Stable.**	Records for most years (46 of 53 years), including 1999 to 2002.
9 Rivers Inlet	*Owikeno Lake and tributaries*	*See text for detailed description of system and status.*		

Statistical Area	Spawning Stream and Lake, Location	Watershed Code	Assessment and Population Size	Frequency of Assessments
9 Fitz Hugh Sound	Beaver Creek and Elsie Lake, mainland side lower Fitz Hugh	910-168500	Records from early 1960s indicate a range of spawners from 75 to 3,500 fish. However, records (n=3) in the 1990s record only 10's of sockeye. Assessment basis is very uncertain, status is **Unknown**.	Infrequent records since 1961, 12 records through 2002.
10, Smith Inlet	*Long Lake and tributaries*	*See text for detailed description of system and status.*		
10, upper Smith Inlet	Walkum Creek	910-038700	No assessment possible, only 3 observations (1 to 25 sockeye) since 1979.	Rare observation of sockeye, only 3 years of record.
10, upper Smith Inlet	Nekite River	910-041700	No assessment possible. Large number of sockeye observed in 1979 not observed again.	Infrequent observations, only 4 records since 1979.
11	General	3 river systems have each had one year of sockeye observations in them, no assessment possible and not likely to be sockeye producing river systems.		

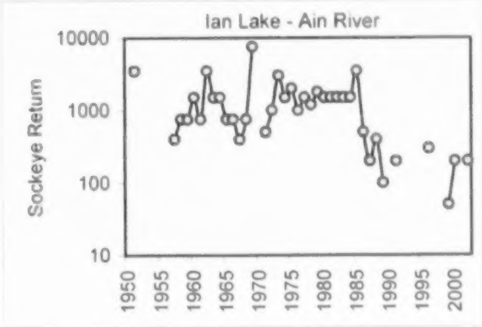
APPENDIX E

Appendix E. Examples of Sockeye return patterns to Queen Charlotte Island (QCI), and coastal areas 3A and 4A populations since 1950.

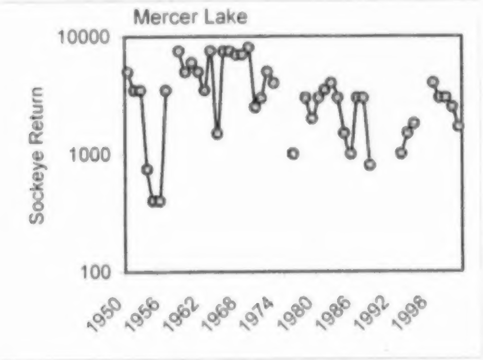
Data presented are spawning escapements by calendar year and blank values on the plots indicate when no sockeye were recorded during a survey, or no survey was conducted.



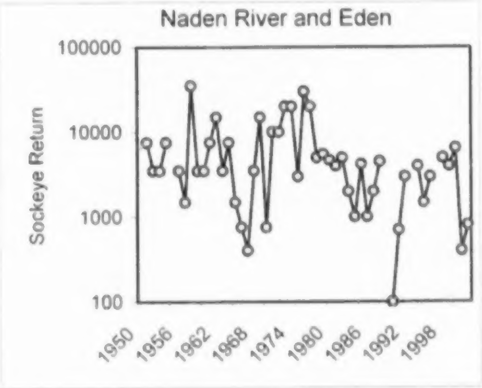
Assessments improved over time and the population is expanding.



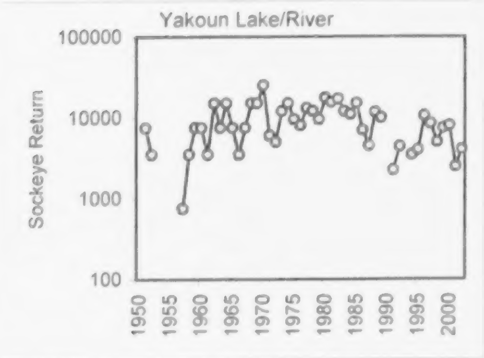
Ian Lake is largest lake on QCI, enters west-side of Masset Inlet, poor surveys recently.



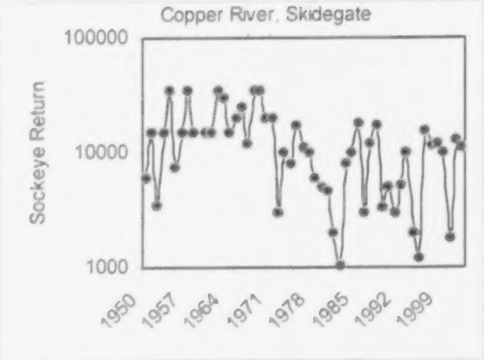
Small lake on west coast of QCI, similar production pattern to Copper R on east coast.



Lake system in northwest corner of QCI. Production has been quite stable until the most recent two years.

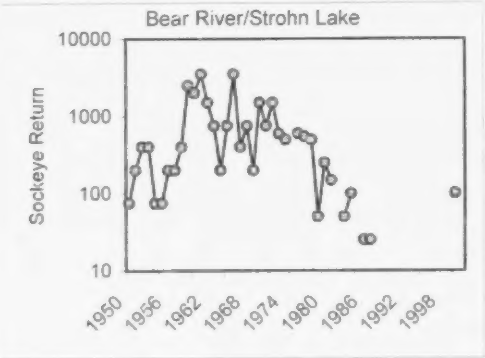


Assessment frequency has been good since late 1950s, two years missed in 1990s. Long-term average escapement about 9,500 sockeye but with some reduction between 1991 and 2002.

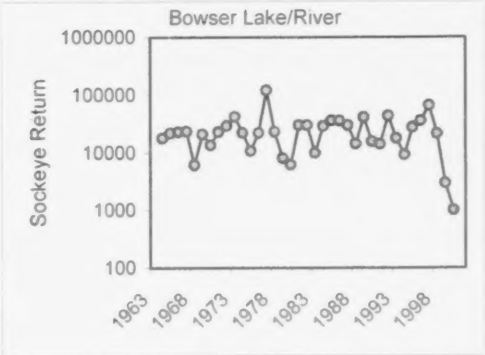


Largest sockeye population on QCI, pre-1975 average return was 18,500 & 1975-2000 average declined to 7,500. During 2001 and 2002 escapement has increased to over 11,000 a year.

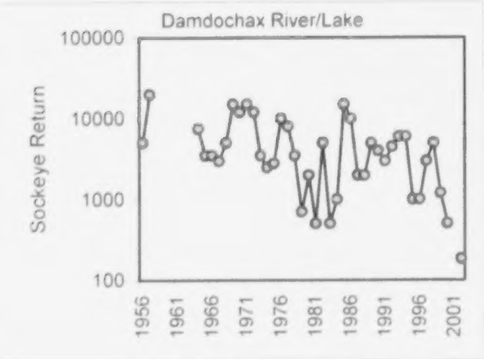
Appendix E. Examples of Sockeye return patterns to Area 3 and Nass River watershed populations.



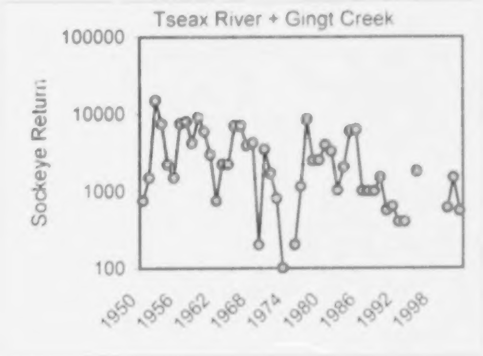
Bear River (upper Observatory Inlet), surveyed through early 1980s but very limited since.



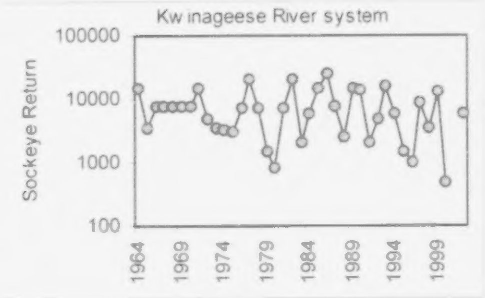
Bowser Lake in Bell-Irving River, upper Nass watershed. Stable production until 1999 and recent values (2001, 2002) unknown.



Damdochax Lake in upper Nass River. Long-term decreasing trend in production, especially since 1999.

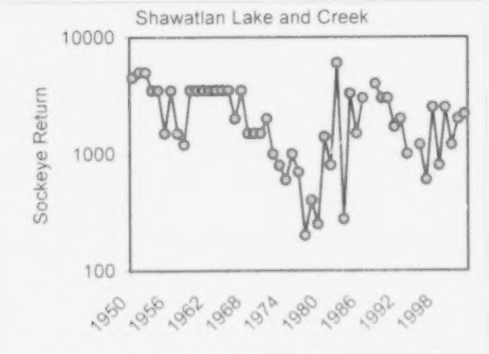


Stream spawning sockeye populations in lower Nass River. Long-term production trend is decreasing

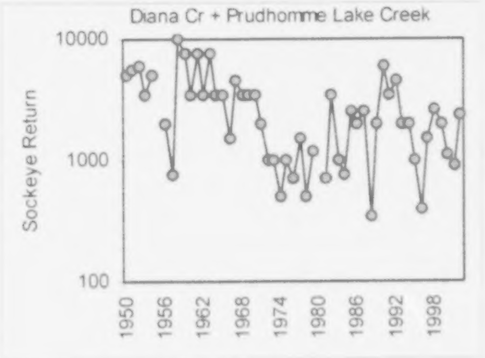


Perception of long-term decline but very modest. Escapement in 2002 recovered to almost 6,000 sockeye

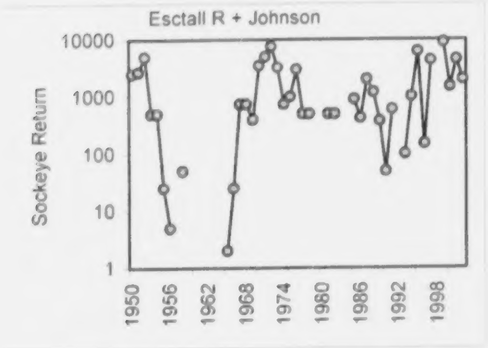
Appendix E. Examples of Sockeye return patterns to coastal Area 4A of the Skeena River watershed.



Shawatlan Lake system is located just east of Prince Ruper. Evidence of recovery from major decrease during 1970s.



Lake system east of Prince Rupert, north shore of Skeena River. Similar pattern to Shawatlan Lake with recovery from 1970s.

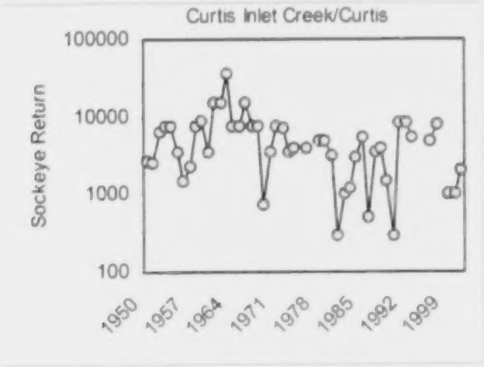


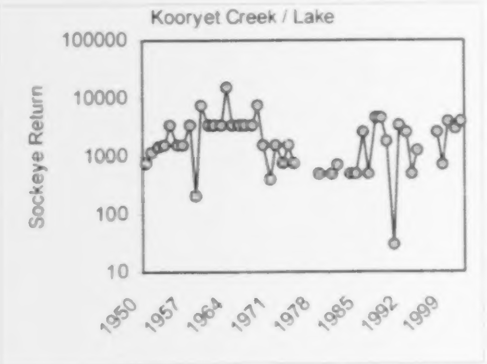
Esctall River and Johnson Lake system is southeast of Prince Rupert. Highly variable escapement records but evidence of recent recovery in sockeye returns.

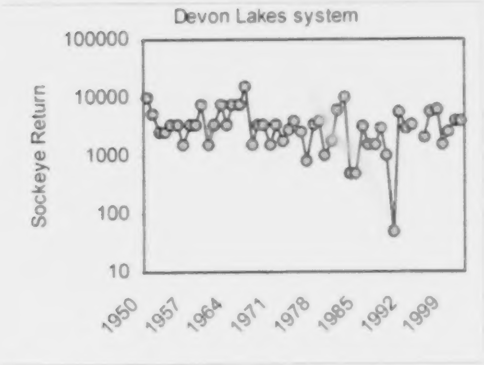
APPENDIX F

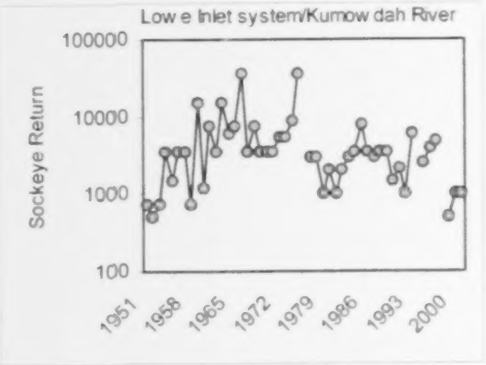
Appendix F. Examples of Sockeye return patterns to north coastal BC (Area 5) populations since 1950.

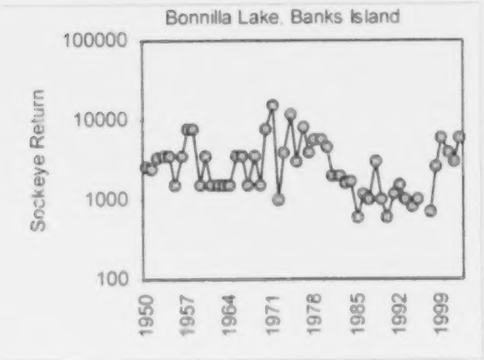
Data presented are spawning escapements by calendar year and blank values on the plots indicate when no sockeye were recorded during a survey, or no survey was conducted.

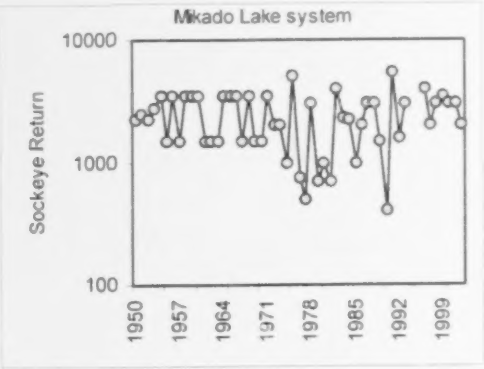


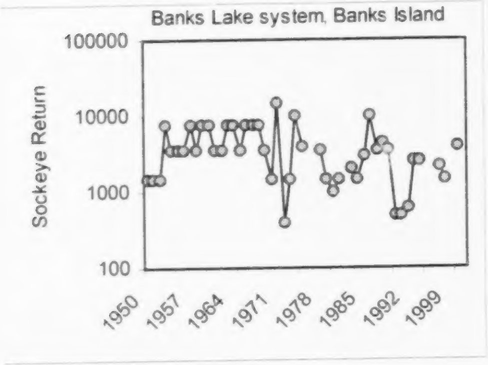


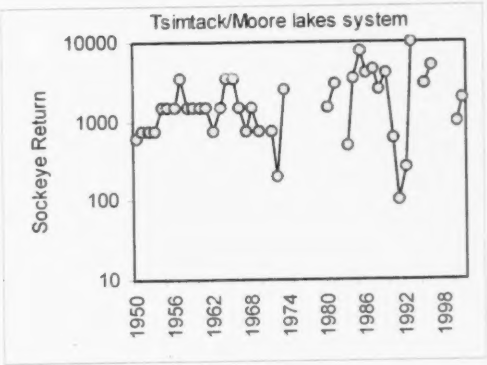









Banks Lake system, Banks Island
Sockeye Return
100000
10000
1000
100
1950
1957
1964
1971
1978
1985
1992
1999

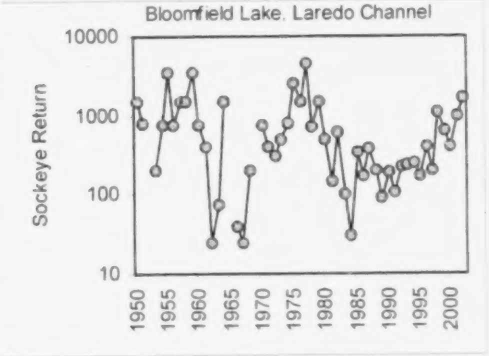

Tsimtack/Moore lakes system
Sockeye Return
10000
1000
100
10
1950
1956
1962
1968
1974
1980
1986
1992
1998

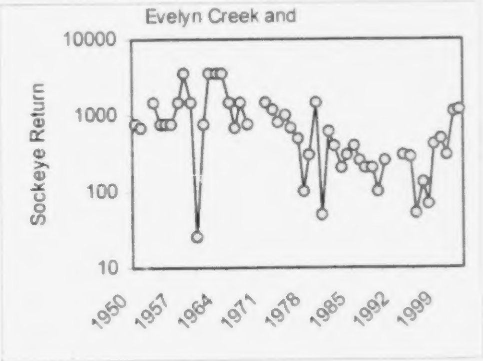
APPENDIX G

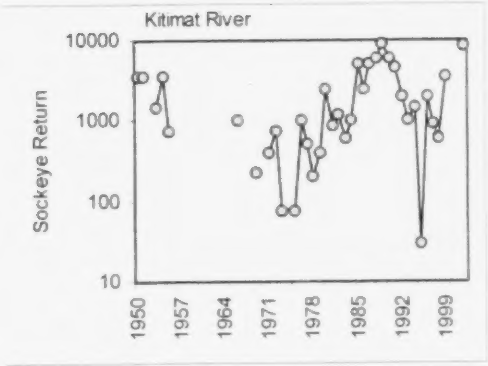
Appendix G. Examples of Sockeye return patterns to Area 6 (Kitimat Arm) through Area 8 in coastal Central BC region.

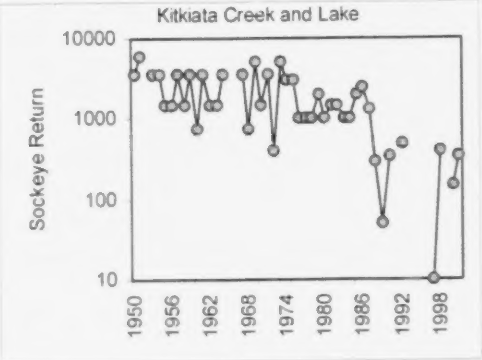
Data presented are spawning escapements by calendar year and blank values on the plots indicate when no sockeye were recorded during a survey, or no survey was conducted.

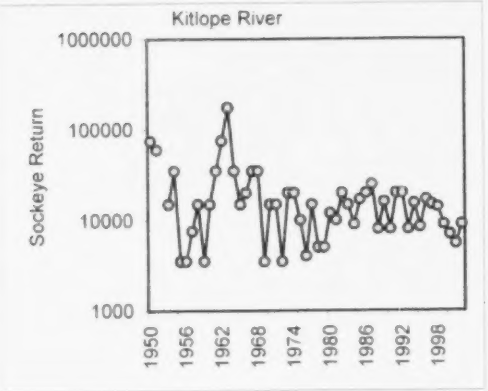
Appendix G. Area 6 Systems

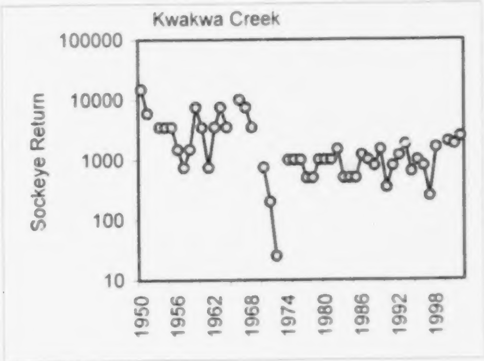


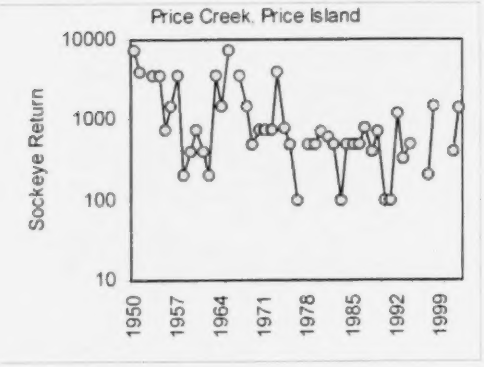


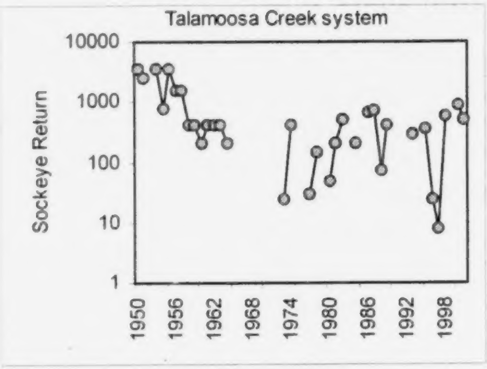




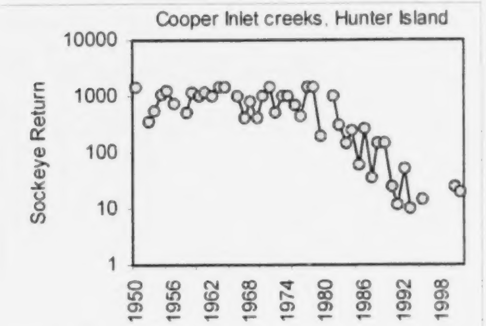


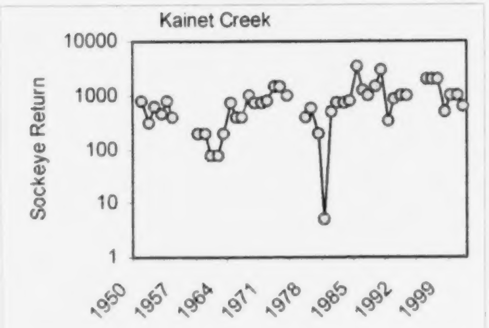


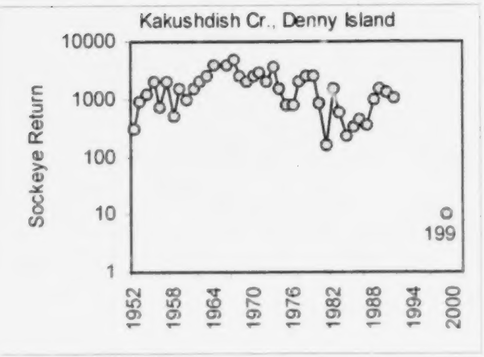


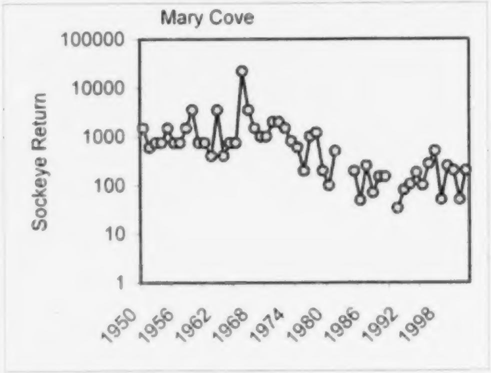


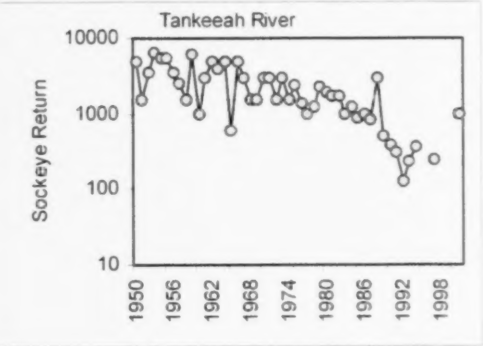
Appendix G. Examples of Sockeye return patterns to Area 7 Coastal Islands and Inlets.

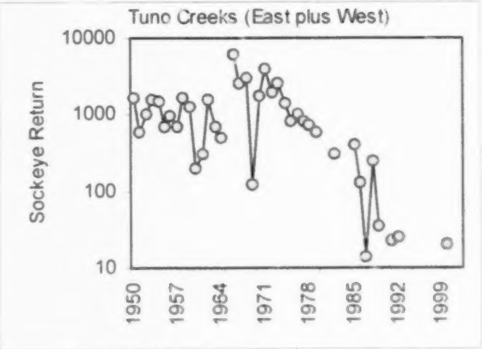




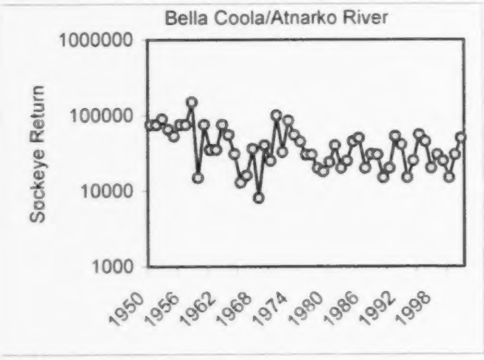


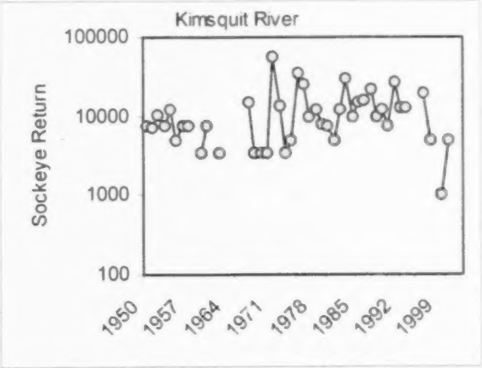


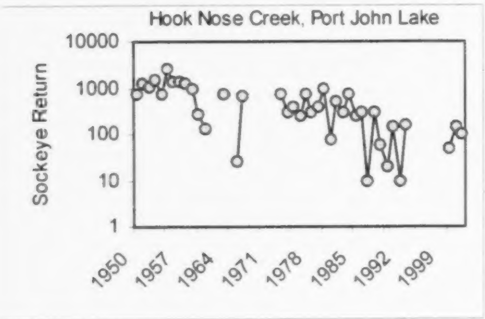


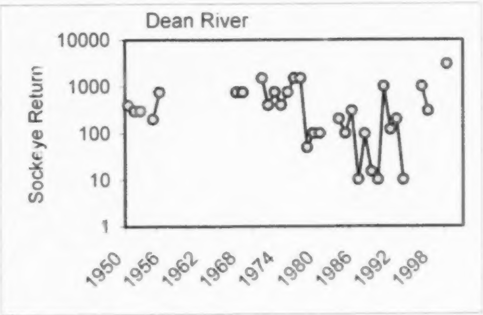


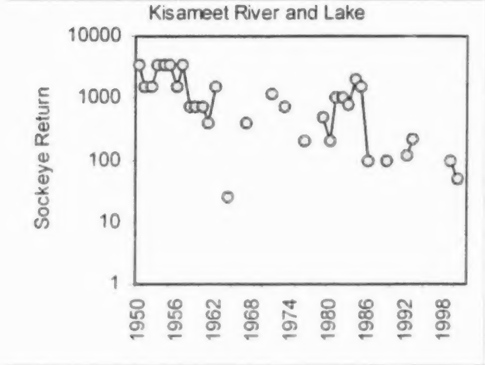
Appendix G. Examples of Sockeye return patterns to Area 8 Coastal Islands and Inlets.

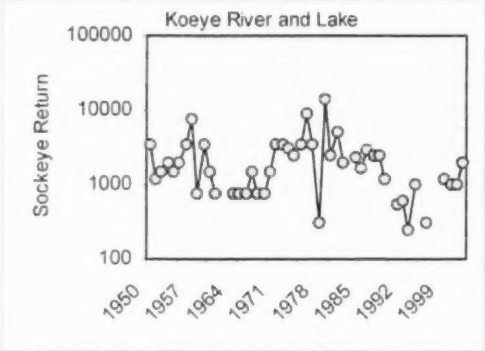


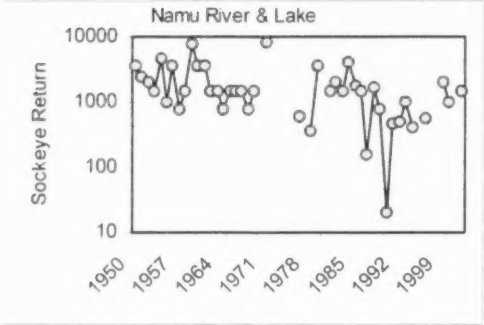







Kisameet River and Lake
Sockeye Return
10000
1000
100
10
1
1950
1956
1962
1968
1974
1980
1986
1992
1998


Koeye River and Lake
Sockeye Return
100000
10000
1000
100
1950
1957
1964
1971
1978
1985
1992
1999


Namu River & Lake
Sockeye Return
10000
1000
100
10
1950
1957
1964
1971
1978
1985
1992
1999

590 - 800 Burrard Street
Vancouver, British Columbia
Canada V6Z 2G7
Telephone: (604) 775 - 5621
Facsimile: (604) 775 - 5622
E-mail: info@fish.bc.ca
www.fish.bc.ca